SEA
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2nd INTERNATIONAL CONFERENCE 3D MEASUREMENT AND IMAGING

MEDZINÁRODNÁ KONFERENCIA 3D ZOBRAZOVANIE A MERANIE (2. ročník)

IMAGING AND ADVANCED DIAGNOSTIC METHODS IN INDUSTRIAL PRACTICE

ZOBRAZOVANIE A MODERNÉ DIAGNOSTICKÉ METÓDY V PRIEMYSELNEJ PRAXI

Abstracts and Presentations

Abstrakty a prednášky

21. - 22. SEPTEMBER, 2017

ODOBORÁRSKA 21, BRATISLAVA

ABSTRACTS AND PRESENTATIONS

2nd INTERNATIONAL CONFERENCE **3D MEASUREMENT AND IMAGING**

IMAGING AND ADVANCED DIAGNOSTIC METHODS IN INDUSTRIAL PRACTICE

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ODOBORÁRSKA 21, BRATISLAVA

Expert Guarantors:

VÝSKUMNÉ CENTRUM ŽILINSKEJ UNIVERZITY V ŽILINE

International Laser Centre

Organized by:

SEA Agentúra pre vzdelanie a vedu

Main Partners:

3DLMI

Allied Vision

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Partners:

EXPERT FOR 3D LANDSCAPE

Nikon

RIEGL LASER MEASUREMENT SYSTEMS

VEXCEL IMAGING

TESCAN PERFORMANCE IN NANOSPACE

Contents

21st September, 2017

TWO-PHOTON MICROSCOPY, MICRO-STEREOLITOGRAPHY AND THEIR APPLICATIONS IN BIOMEDICINE

Dušan Chorvát [1], Tibor Teplický [2]
[1] International Laser Centre, Bratislava
[2] University of St. Cyril and Methodius, Faculty of Natural sciences, Trnava

Abstract

Design and fabrication of biocompatible microstructures is an important prerequisite for number of biomedical experiments. In this regard, two photon photopolymerization is a very useful tool for creation of micro and nano structures. It uses laser beam with longer wavelength and energy below the polymerization threshold, where the threshold can be reached in the focus by multi-photon absorption process. Moving of the laser focus spot through the resin allows to build up a complete 3D structure of a chosen design with micrometer resolution. Polymer structures presented in this work were made by 2-photon photopolymerisation of OrmoComp (Micro Resist Technology GmbH) using uFAB workstation (Newport) with Spirit ultrafast amplified laser running at 520nm.

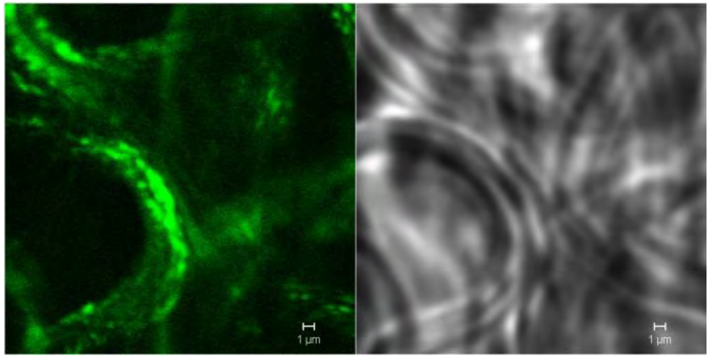

Fig 1 : Collagen matrix in rat aorta imaged by second harmonic generation microscopy (left) compared to transmitted light imaging (right).

Multimodal imaging combined with pulsed laser excitation is currently a leading-edge technology of optical microscopy. In particular, the combination of imaging, steady-state spectroscopic methods with time-resolved detection techniques provides more precise insight into native cell behaviour. Excitation by near infrared pulsed laser allows better spatial separation of fluorescence signal, as well as utilization of nonlinear imaging modes such as second-harmonic generation. In our contribution we present data obtained from confocal microscope LSM 510 META (Zeiss) with nonlinear optical excitation by ytterbium laser (t-pulse 50, Amplitude Systemes, 1040nm), combined with spectrally and time-resolved fluorescence imaging (Becker & Hickl HPM 100-40 detectors, BDL-475 laser and SPC-830 TCSPC board). We present application of this system for imaging of various biomedical structures and processes, such as the study of collagen in native tissue samples (Fig.1).

Acknowledgements

Supported by EU Horizon 2020 research and innovation programme under grant agreement No. 654148 Laserlab-Europe. We acknowledge Dr.M. Uherek for providing rat aorta samples.

Allied Vision

KVANT®

member of the TKH Group

The future of machine vision cameras in embedded Applications

Christoph Noth | Sales Manager EMEA

Agenda

// Allied Vision – Who we are?

// The advantages and disadvantages of designing a machine vision camera based on ASIC technology

// What is MIPI CSI-2 and why is it a relevant Interface for machine vision?

// Characteristics of embedded vision systems

Allied Vision-
Who we are?

Allied Vision

The Right Camera for Each Application

KVANT

Essential

Ultra-compact, affordable cameras with basic feature set for simple plug-and-play integration into commonly used image-processing systems.

Guppy PRO

Mako

Enhanced

Versatile cameras offering a large choice of sensors, modular options, and integrated image optimization functions for advanced machine vision applications.

Manta

Stingray

Extreme

High-performance cameras with special features such as high resolution, extended operating temperature range or infrared sensitivity to fulfill the most demanding requirements.

Prosilica GT

Goldeye

Allied Vision

Applications Examples

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Industrial Inspection

Ziemann & Urban
Inspection of BMW instrument panel carriers

Healthcare & Medical

Carl Zeiss Meditec
Opthtalmologic examination device

Science & Nature

NASA
ISS astronaut-robot Robonaut 2

Security & Traffic

Kria
Radar-free speed enforcement

Multimedia & Entertainment

Forever 21/space150
Times Square, NYC giant interactive billboard

Allied Vision

Our Success-Story

1989	Company founded as M. Sticksel CCD-Kameratechnik GmbH (Sony distribution)
1996	Production facilities opened in Stadtroda, Germany
2000	Acquisition by Augusta Technologie AG
2001	Renaming to Allied Vision Technologies R&D center opened in Ahrensburg, Germany
2002	Launch of Dolphin, first Allied Vision-developed and Allied Vision-built camera
2006	Allied Vision Technologies, Inc. opened in Newburyport, MA (USA)
2008	Acquisition of Prosilica, Inc. in Burnaby, BC (Canada)
2010	Prosilica, Inc. renamed Allied Vision Technologies Canada Inc. Allied Vision Technologies Asia Pte. Ltd. opened in Singapore
2011	Acquisition and integration of VDS Vosskühler GmbH in Osnabrück, Germany. Entry into the infrared market
2012	Allied Vision Technologies (Shanghai) Co. Ltd. opened in Shanghai, China
2014	New branding to Allied Vision
2015	Allied Vision becomes a member of the TKH Group

Allied Vision

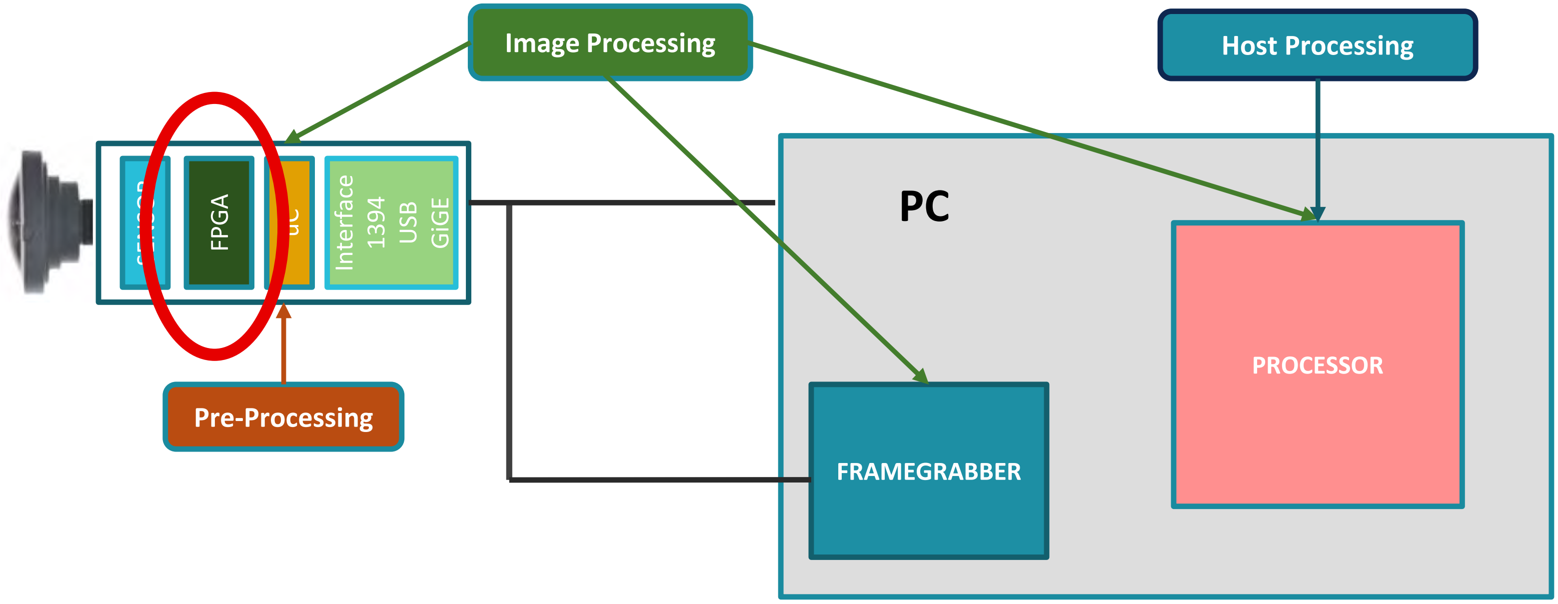
A Global Player

- 8 locations worldwide
- Distribution partners in more than 30 countries

The advantages and disadvantages of designing a machine vision camera based on ASIC technology

Allied Vision

Typical Machine Vision Architecture



What is an FPGA

*“A **field-programmable gate array** (**FPGA**) is an integrated circuit (IC) **designed to be configured** by a customer or a designer after manufacturing.”*

What is an ASIC

*“An **application-specific integrated circuit (ASIC)** is an integrated circuit (IC) customized for a particular use, rather than intended for general-purpose use.”*

General ASIC vs FPGA overview - this sums it up nicely

	FPGA	ASIC
Time to Market	Fast	Slow
NRE	Low	High
Design Flow	Simple	Complex
Unit Costs	High	Low
Unit size	Medium	Low
Perfomance	Medium	High
Power consumption	High	Low

Effort required to develop an ASIC

Market Analysis

ASIC Design

- Architecture Specification
- CODE Generation
- Synthesis
- Pre-Layout Verification
- Design Implementation
- Physical Implementation
- Post-Layout Verification
- Physical Verification
- Post-Layout Review

ASIC Production

- Mask Tooling
- Fabrication
- Wafer Sort
- Assembly
- Final Test
- Chip Qualification
- Chip Characterization
- Chip Reliabilty
- Corner Split

Final ASIC

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Practical considerations of using an ASIC for a machine vision camera design

KVANT

// Market trend towards embedded vision systems

Cameras with low power consumption and small size required

// More and more mass volume vision applications

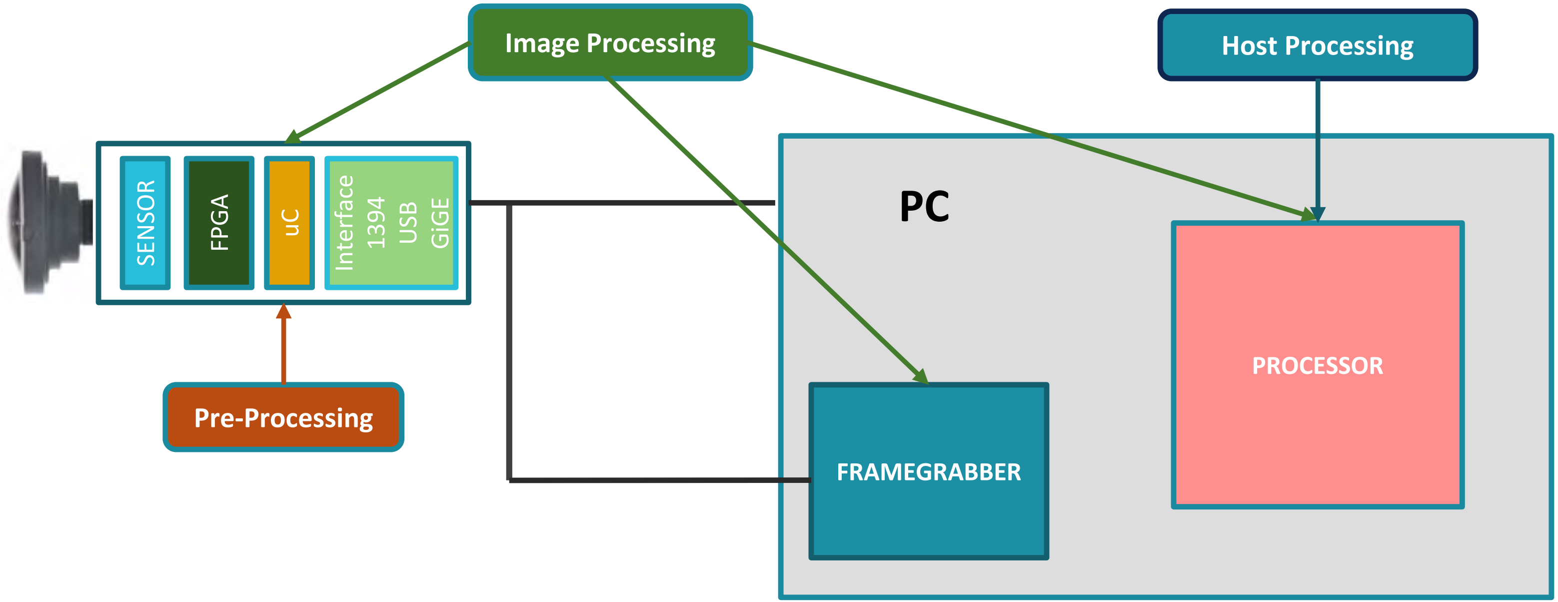
Low cost cameras with dedicated perfomance required

Allied Vision

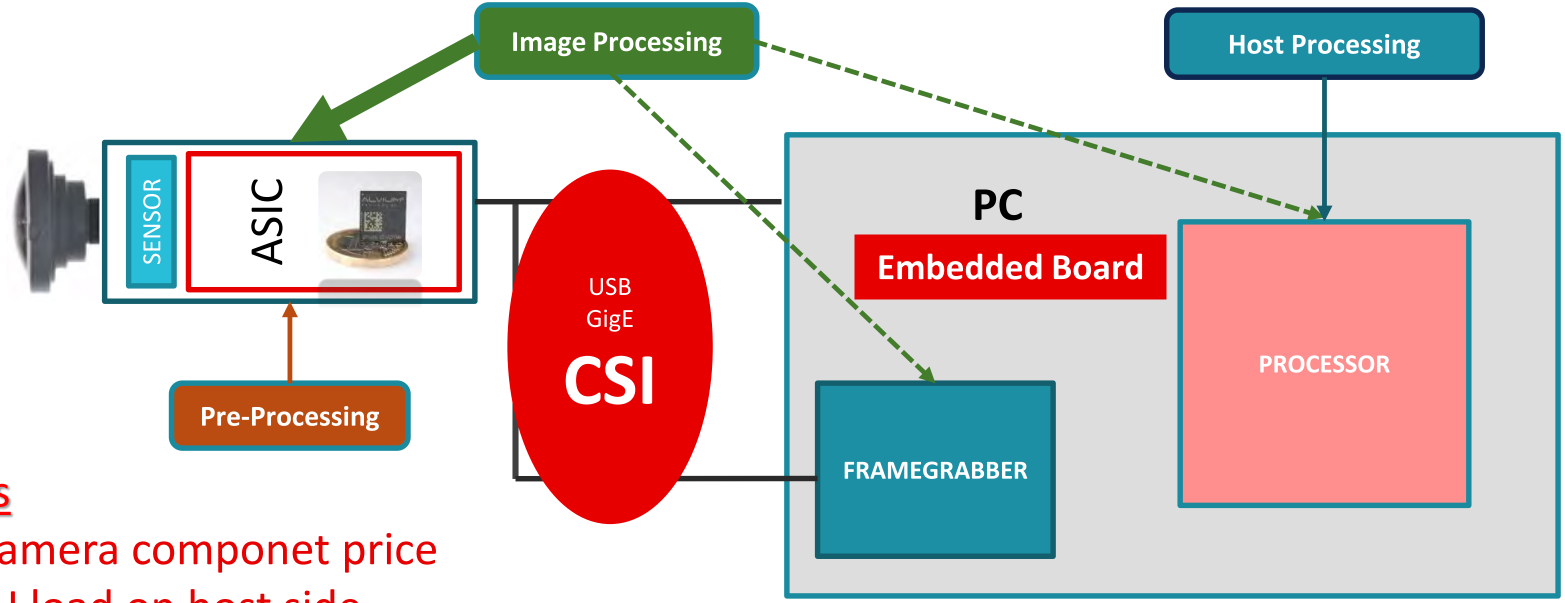
Comparison of an established camera versus new ASIC based camera

	FPGA based camera	ASIC based camera
Power consumption	High	Low
Unit size	Medium	Small
Costs	Higher unit costs / Low NRE	Low unit costs / High NRE
Feature level	Oversized	Dedicated to application
Time to Market	Fast	Slow
Perfomance	Lower	High

Typical Machine Vision Architecture



ASIC based machine vision Architecture



Advantages

- Lower camera componet price
- Less CPU load on host side
- Less power consumption
- Higher perfomance
- ***!!! New Interface: CSI !!!***

What is MIPI CSI-2 and why is it a relevant Interface for machine vision?

Allied Vision

What is CSI?

// CSI stands for Camera Serial Interface

// and is a specification of the

// Mobile Industry Processor Interface (MIPI)

alliance.

Prevalence of CSI-2 on embedded processing boards

Consumer World

No <u>high quality</u> machine vision senors available!

Comparison of CSI-2 to other commonly used Machine Vision Interfaces

	CSI-2 D-PHY	USB3.0 USB 3.1	GigE Vision
Bandwidth	Up to 2.5Gbit/s per lane 4 lanes up to 10GBit/s	5GBit/s	1GBit/s
Cable Length	Up to 0.6m	Up to 8.0m	Up to 100m
Integration effort	High	Easy	Easy
CPU load on host	Low	High	High
Availability on embedded boards	High	Limited (only high-end)	Limited (only high-end)

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Adopters of CSI-2 – Embedded boards & CoM

- Broadcomm 64bit QuadCore ARMv8
  - Raspberry Pi Zero (10€) *(CSI-2…yes we can ☺…)*
  - Raspberry Pi 3 model B (35€)
    - Quad Core 1.2GHz Broadcom BCM2837 64bit CPU
    - 1GB RAM
    - BCM43438 WiFi and Bluetooth Low Energy (BLE) on board
    - 40-pin Extended GPIO
    - 4x USB 2 ports
    - 4 Pole stereo output and composite video port
    - HDMI
    - CSI camera port for connecting a Raspberry Pi camera
    - DSI display port for connecting a Raspberry Pi touchscreen display
    - Micro SD port for loading your operating system and storing data

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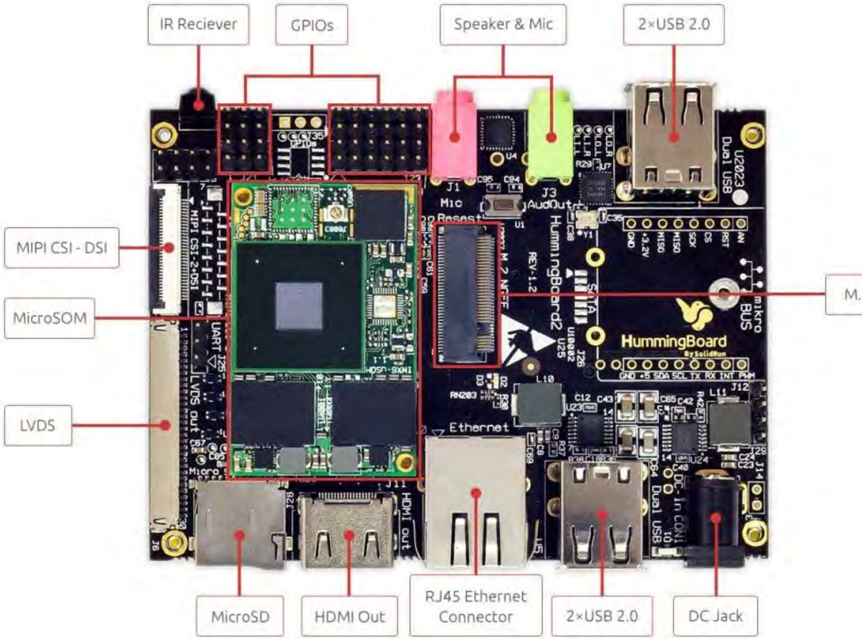
Adopters of CSI-2 – Embedded boards & CoM

- **NXP Freescale ARM Cortex - iMX6 solo/Dual/Quad**
  - **SoM modules for iMX6 by SolidRun (85€)**



!!! Issue is only USB2.0 ports but CSI-2 and Ethernet 1Gb with IEEE1588 ☺

Adopters of CSI-2 – Embedded boards & CoM

KVANT

- **NVIDIA**
  - **JETSON TK1 & TX1 CoM modules (500€)**

UNMATCHED PERFORMANCE

- The world's first supercomputer on a module
- Highest performance and power efficiency
- Revolutionary NVIDIA Maxwell™ architecture with 256 CUDA cores delivering over 1 TeraFLOPs
- 64-bit CPUs
- 4K video encode and decode capabilities
- camera interface capable of 1400 MPix/s
- Applications:
  Computer vision, graphics, and GPU computing.

Embedded machine vision application

Allied Visions
1 Productline

Characteristics of embedded vision systems (low power/size/runtime cost; high effort/upfront development cost)

Allied Vision

Characteristics of embedded vision systems (low power/size/runtime cost; high effort/upfront development cost)

Application

Embedded System		PC-based System
YES	Does size and weight matter?	NO
YES	Does power consumption matter?	NO
NO	Do you plan to expand your system in the meantime before the next generation?	YES
YES	Do you have a demanding environment?	NO
Design Costs > **Recurring Costs**	What about the costs?	**Design Costs <** Recurring Costs

Allied Vision

Thank You/Q&A

DELIVERING INLINE METROLOGY WITH FACTORYSMART® SENSOR TECHNOLOGY

Christian Benderoth [1]
[1] Regional Development Manager EMEA, LMI Technologies

Abstract
In this talk, LMI will discuss the state of the metrology industry, which has largely focused on first article or random part inspection for comparison to CAD or reverse engineering. With the increasing need for inline metrology, LMI will present how 3D smart sensors provide an effective solution to achieving 100% quality control leveraging new multi-sensor capabilities to deliver inspection solutions that can reach a high degree of accuracy and repeatability in correlation to CMM machine studies.

DELIVERING INLINE METROLOGY WITH FACTORYSMART SENSOR TECHNOLOGY

2nd International Conference 3D Measurement and Imaging

21 September, 2017

Christian Benderoth
Managing Director / Regional Development Manager

KVANT

LMI TECHNOLOGIES

QUICK FACTS

Owned by TKH Group

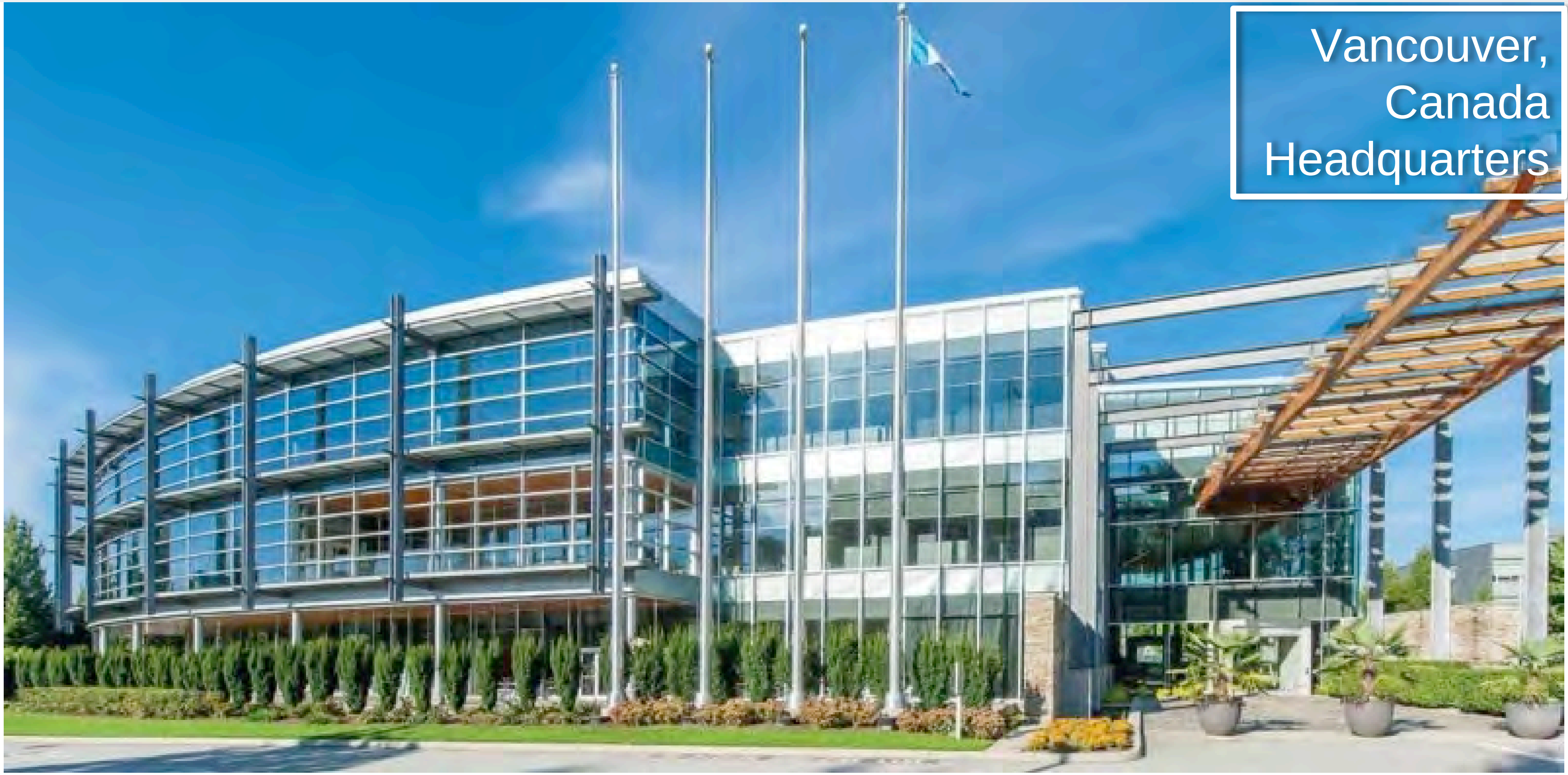
39+ years experience
1978 – Present

One of our Selcom displacement sensors developed in the 1970s

100+ patents
and 220+ employees

110,000+ sensors
in the field

ABOUT LMI TECHNOLOGIES



GLOBAL PRESENCE

ABOUT LMI TECHNOLOGIES

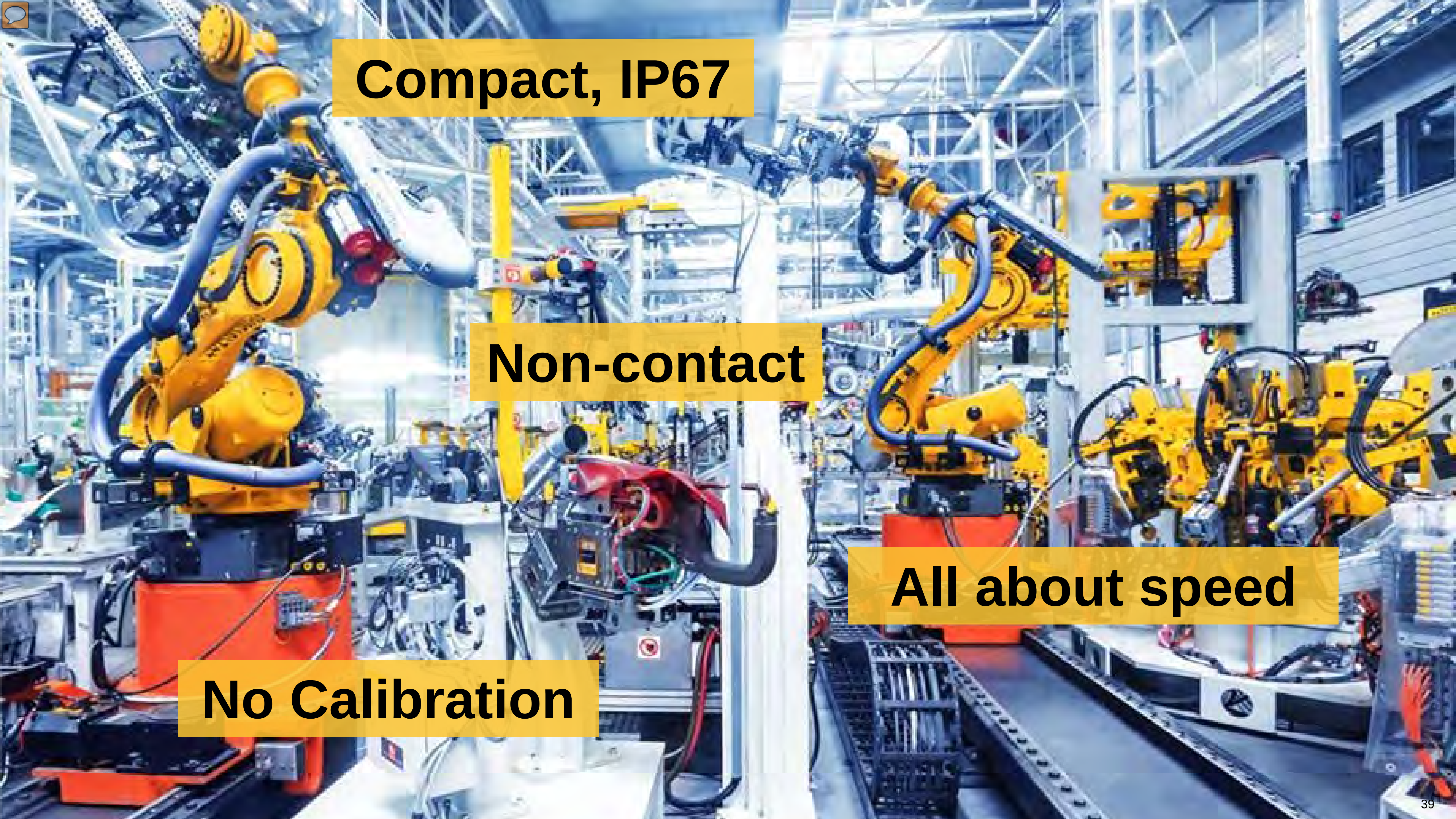
UNIQUE BUSINESS APPROACH

CHIP LEVEL ENGINEERING		SIMPLE USER EXPERIENCE	PROGRESSIVE PARTNERSHIPS
We design and deliver proven technologies at the lowest cost		You don’t need to be a rocket scientist to use our products – just point and click	We build OEM and SI solutions in support of our long term partnerships

STATE OF METROLOGY

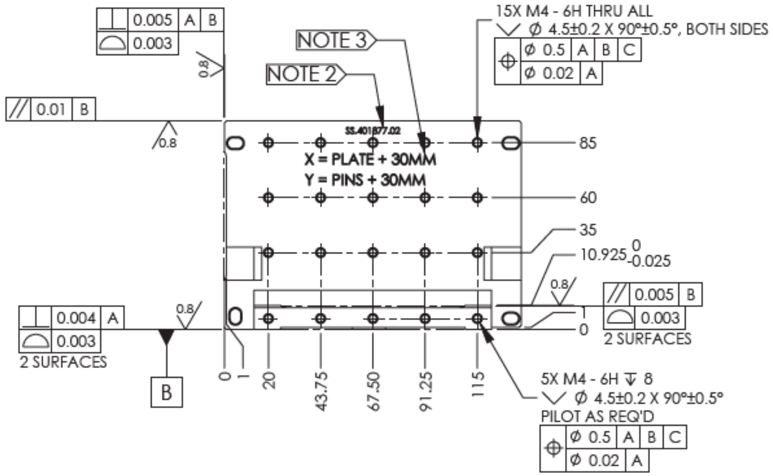
» Why can't we achieve accuracy and precision in the factory?


Lab environment
Calibration required
Contact-based
Slow
FLASH


Compact, IP67
Non-contact
All about speed
No Calibration

TYPICAL METROLOGY PROCESS

- Metrology today has traditionally focused on acquiring accurate 3D scans of real world objects, for:
  - Comparison of first articles to CAD models

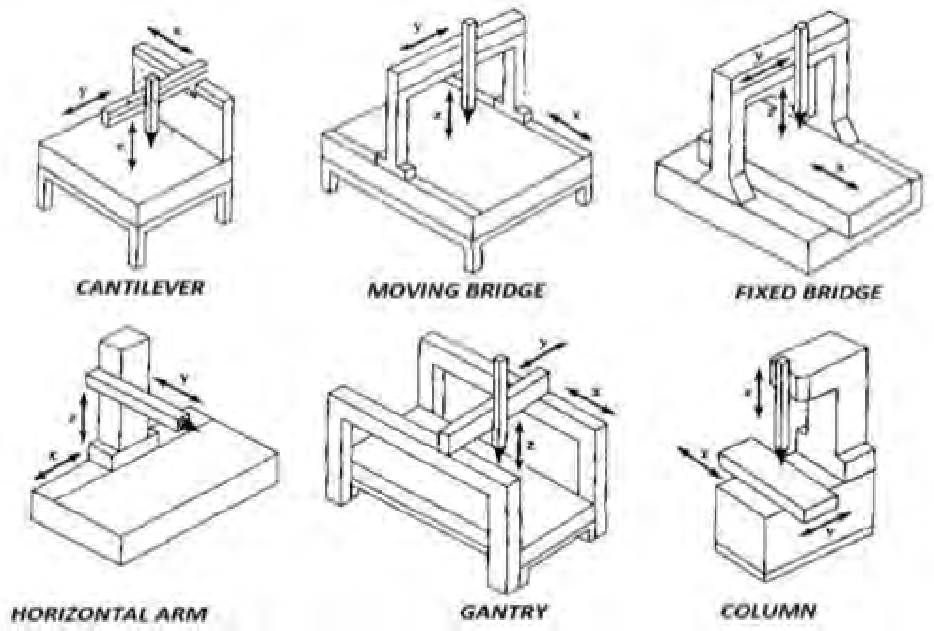


TYPE OF TOLERANCE	CHARACTERISTIC	SYMBOL
FORM	STRAIGHTNESS	⏤
	FLATNESS	▱
	CIRCULARITY	○
	CYLINDRICITY	⌭
PROFILE	PROFILE OF A LINE	⌒
	PROFILE OF A SURFACE	⌓
ORIENTATION	ANGULARITY	∠
	PERPENDICULARITY	⊥
	PARALLELISM	//
LOCATION	POSITION	⌖
	CONCENTRICITY	◎
	SYMMETRY	⌯
RUNOUT	CIRCULAR RUNOUT	↗
	TOTAL RUNOUT	⌰

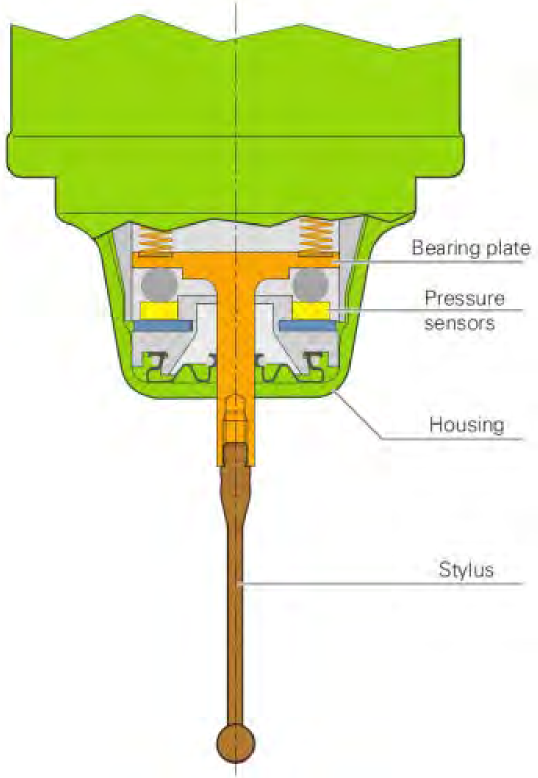
TYPICAL METROLOGY MACHINE

Coordinate Measuring Machine

- A 3D device for measuring the physical geometrical characteristics of an object
- Manually controlled by an operator or computer



Mechanical CMM Structures



FROM THE LAB TO THE FACTORY FLOOR

- Over the past 5 years, advances with structured light scanners or handheld portable scanners with laser trackers have produced 3D scans sufficiently fast and accurate enough to move onto the factory floor to support random sampling part verification.
- Contact based → non contact-based

COMPARISON: METROLOGY VS. INSPECTION

Metrology	Inspection
Offline in measuring room, clean and controlled	In-line or at-line (if not fast enough), factory environment introduces lots of variation (ambient light, vibration, temp, dust, water, oil, etc.)
Largely contact based using touch probes	Always non-contact based using lasers or structured light
Long acquisition process; takes minutes	Short acquisition, short tact/cycle times; take milliseconds
Highest level of accuracy; performs GD&T analysis and reporting	Performs PASS/FAIL and communicate results with all factory networking protocols
Requires regular or frequent calibration	No calibration needed!

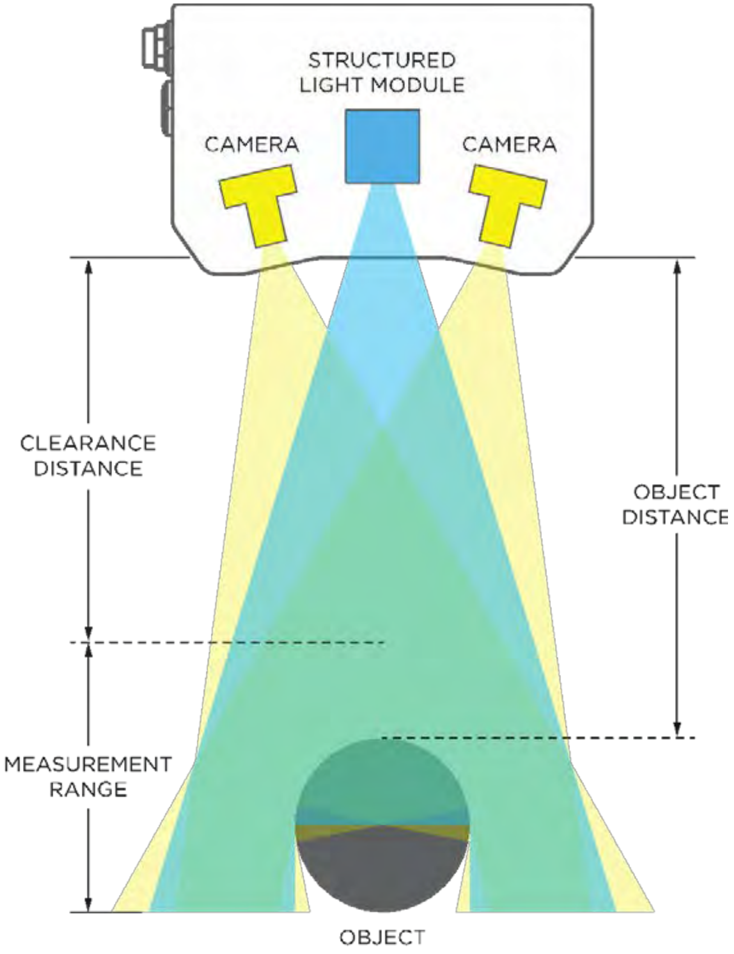
KVANT

THE NEW STATE: INLINE METROLOGY

Inline Metrology	
	In-line, factory environment introduces lots of variation (ambient light, vibration, temp, dust, water, oil, etc.)
	Always non-contact based using lasers or structured light
	Short acquisition, short tact/cycle times; take milliseconds
Highest level of accuracy with high repeatability	Performs PASS/FAIL and communicates results
	No calibration needed!

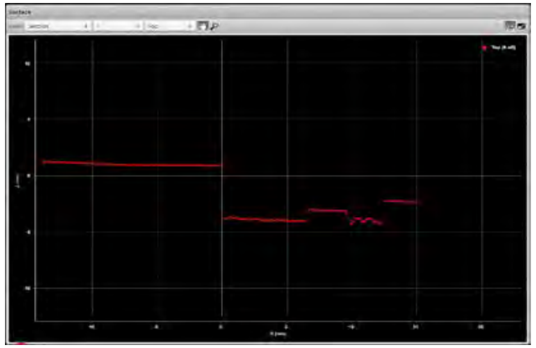
TYPICAL INLINE MEASUREMENT DEVICES

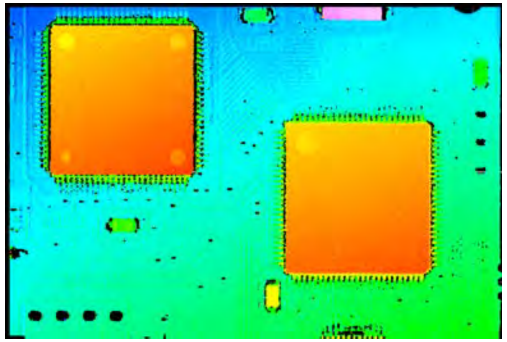
- 3D sensor technologies:
  - Laser triangulation
  - Structured light
- Industrial housing
- Calibrated once in the factory, holds accuracy in industrial environments
- Embedded processing makes hardware “smart”

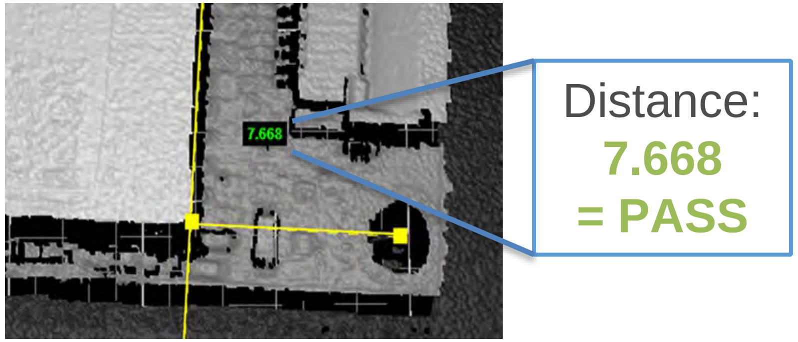


TYPICAL INSPECTION PROCESS

- Inspection carries out scanning, measurement, and control – all inline while a part is in motion:
  - A trigger causes a profile scan or an area scan
  - 3D point clouds are generated
  - Measurements computed
  - Check to tolerances
  - Communicate pass/fail



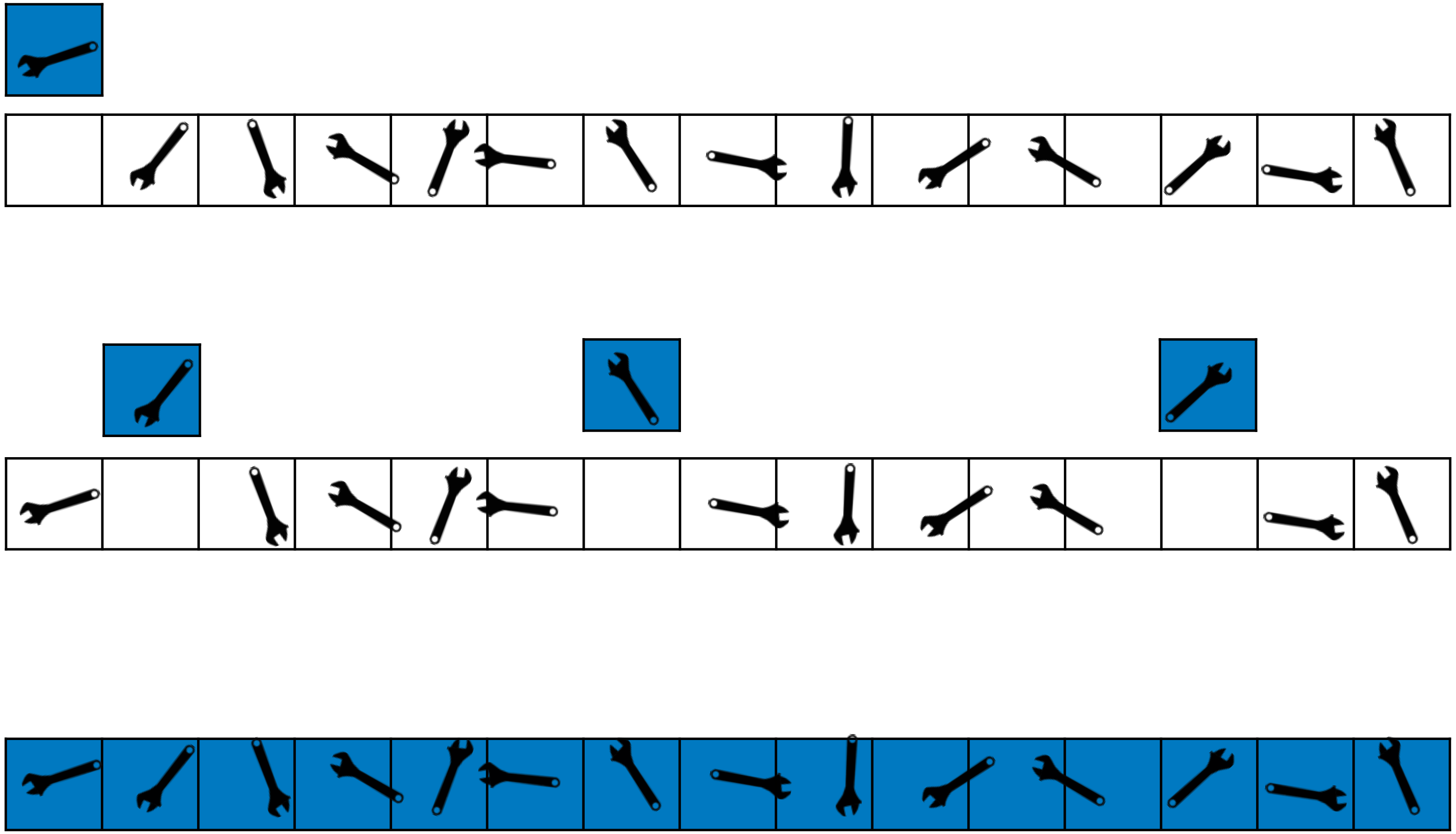




Scan Part → Collect 3D Profiles → Create Height Maps → Measurement/Check Tolerances → Communicate PASS/FAIL

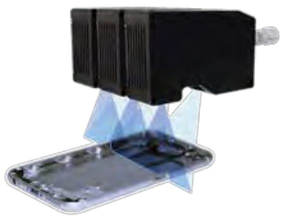
TOWARDS 100% QUALITY CONTROL

Part Inspection



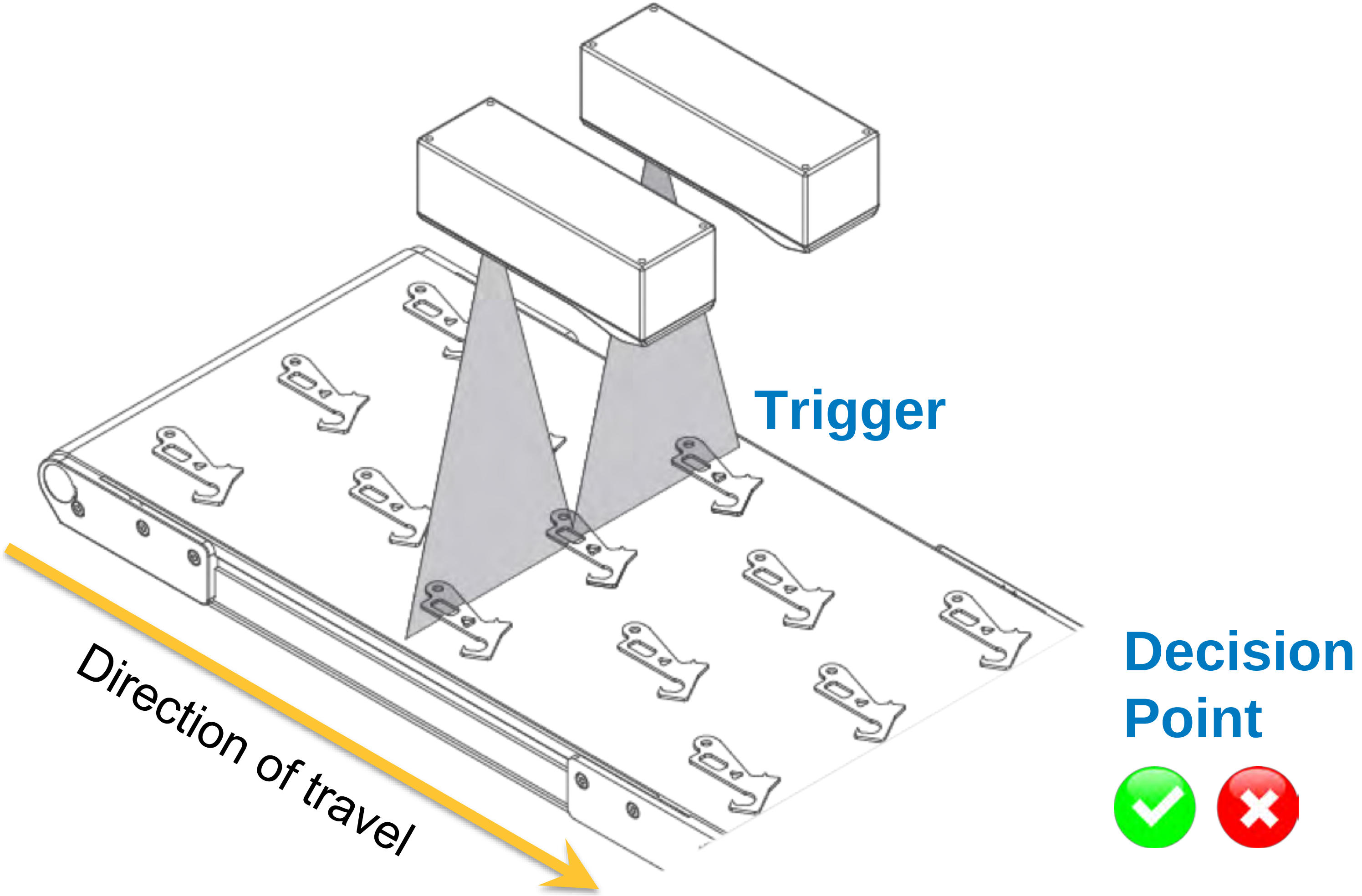
At-line
Random part
inspection

In-line 100%
part inspection

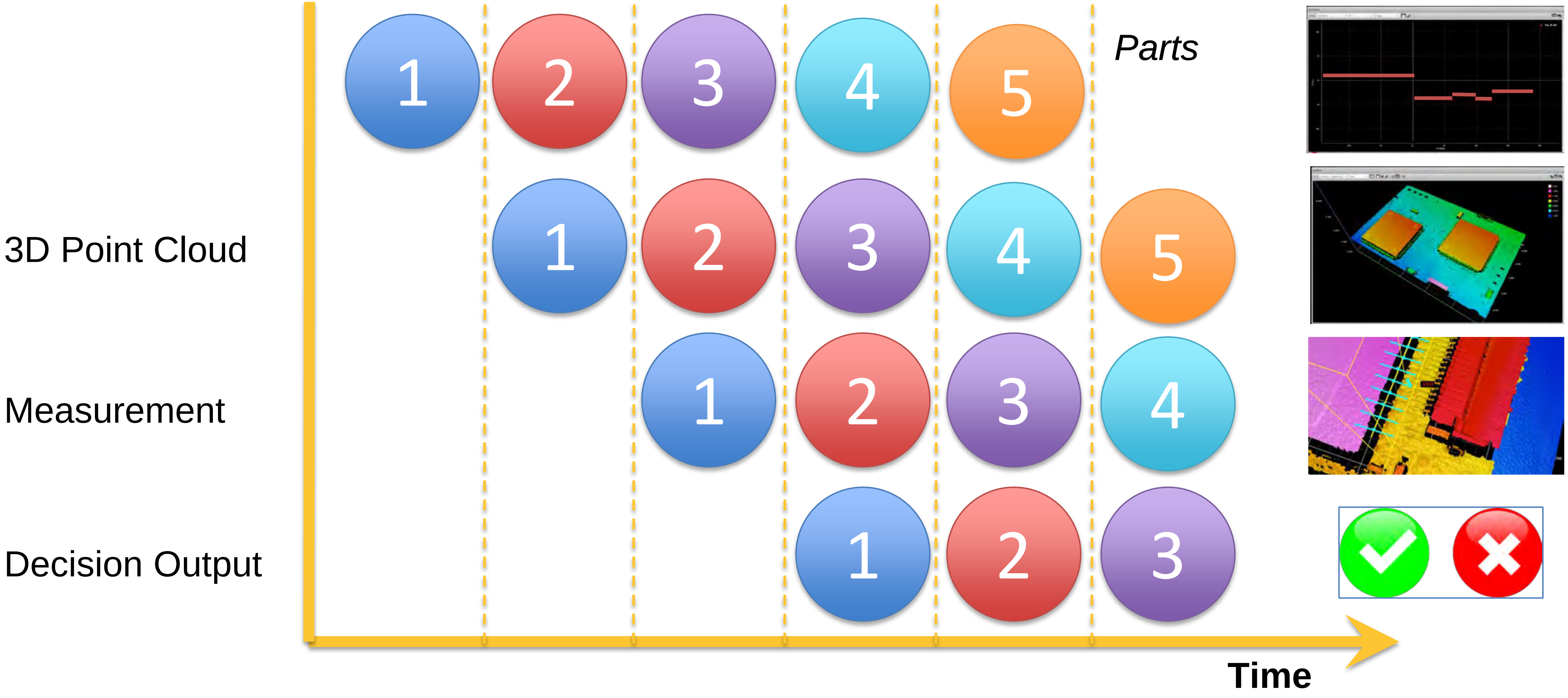


TOWARDS 100% QUALITY CONTROL

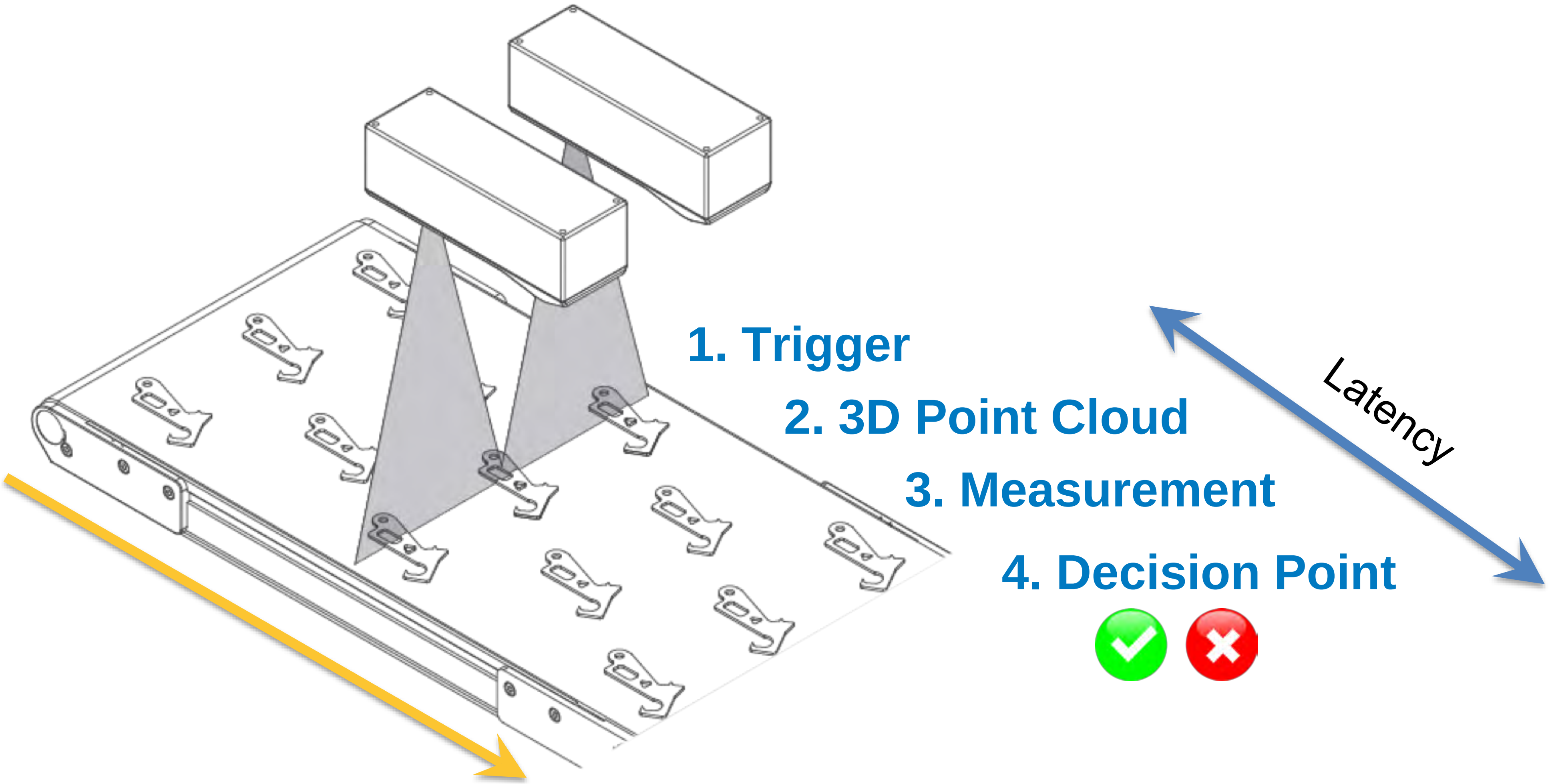
- Need for speed increases
  - Acquisition time is short: scanning, measuring
  - Running in milliseconds
- Size of measuring devices become smaller (because of space constraints)



GOCATOR REAL-TIME PIPELINE PROCESSING



GOCATOR PIPELINE LATENCY



SMART STANDALONE VS. PC

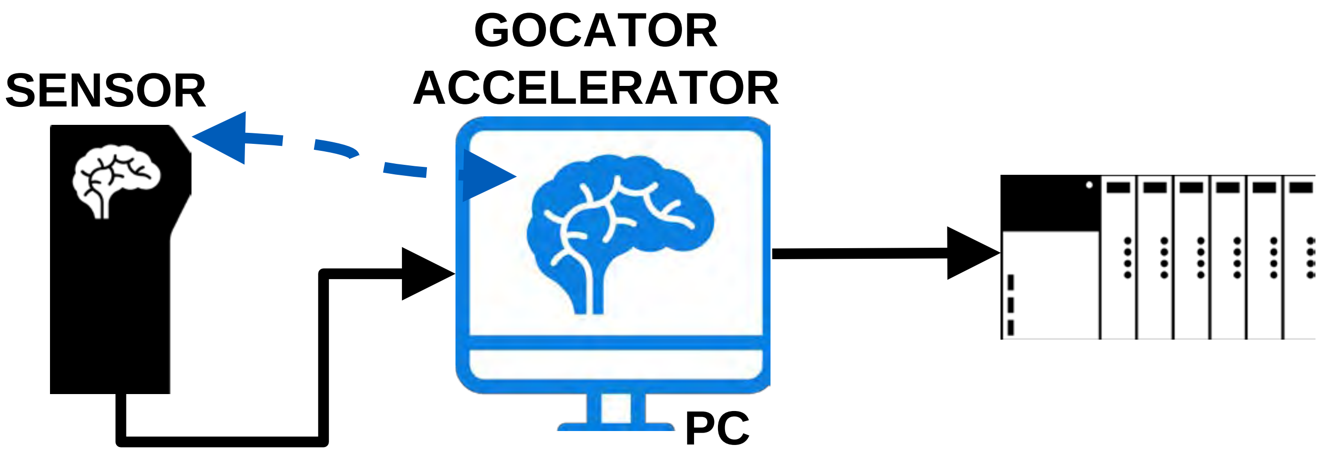
- Trigger
- 3D point cloud generation
- Part segmentation
- Part rotation
- Part sectioning
- Measurement
- Pass/fail decision outputs

PC-Accelerated

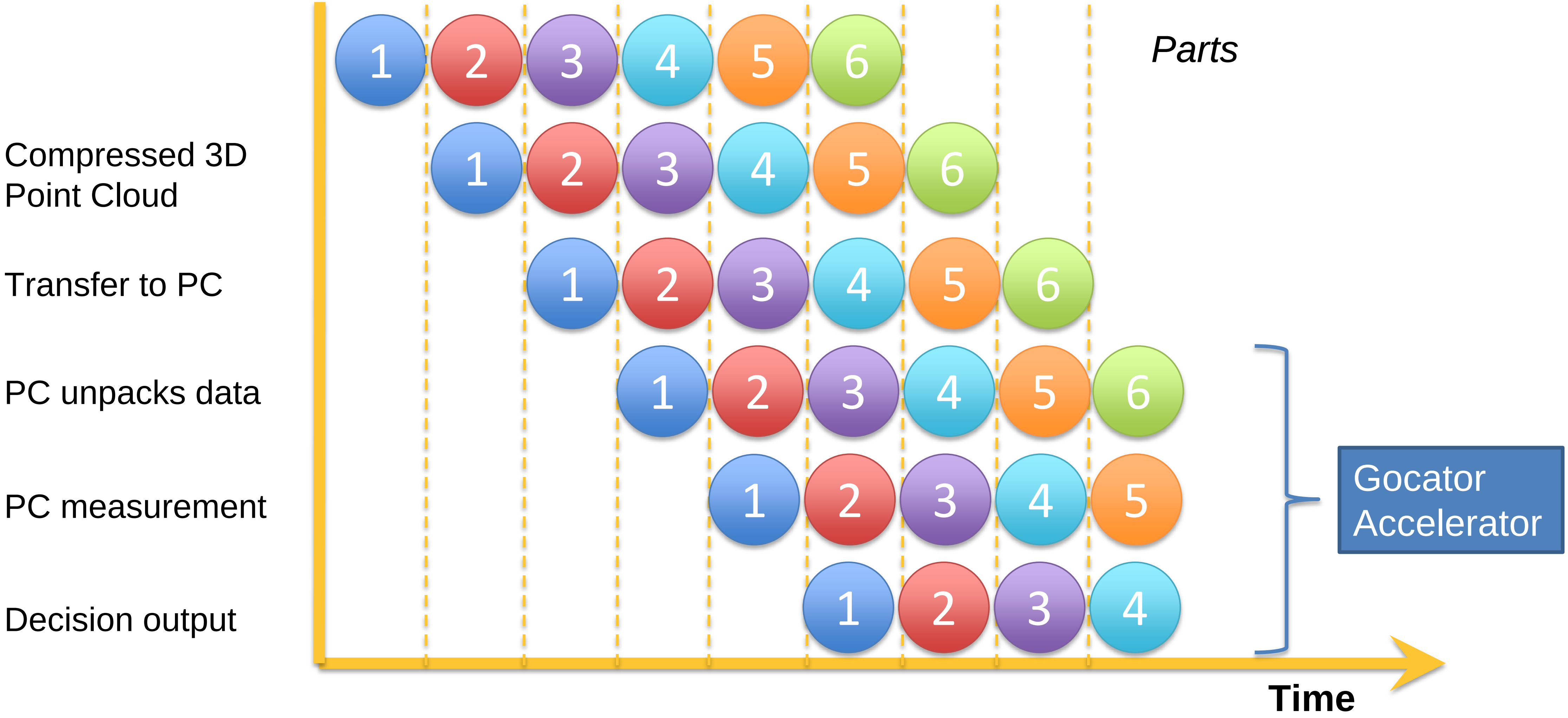
- Speed up processing times to reduce cycle times
- Manage and control multiple sensors
- Stitch multiple 3D point clouds

SEAMLESS ACCELERATION

- With Gocator Accelerator:
  - Adds faster data-processing power
  - Windows PC application that adds the processing power of one or more PCs
  - Reduce cycle time and remove memory limitations



FASTER PIPELINED RESULTS WITH ACCELERATOR



GOCATOR MULTI-SENSOR NETWORKING CAPABILITIES

» Need a wider view or different angles?

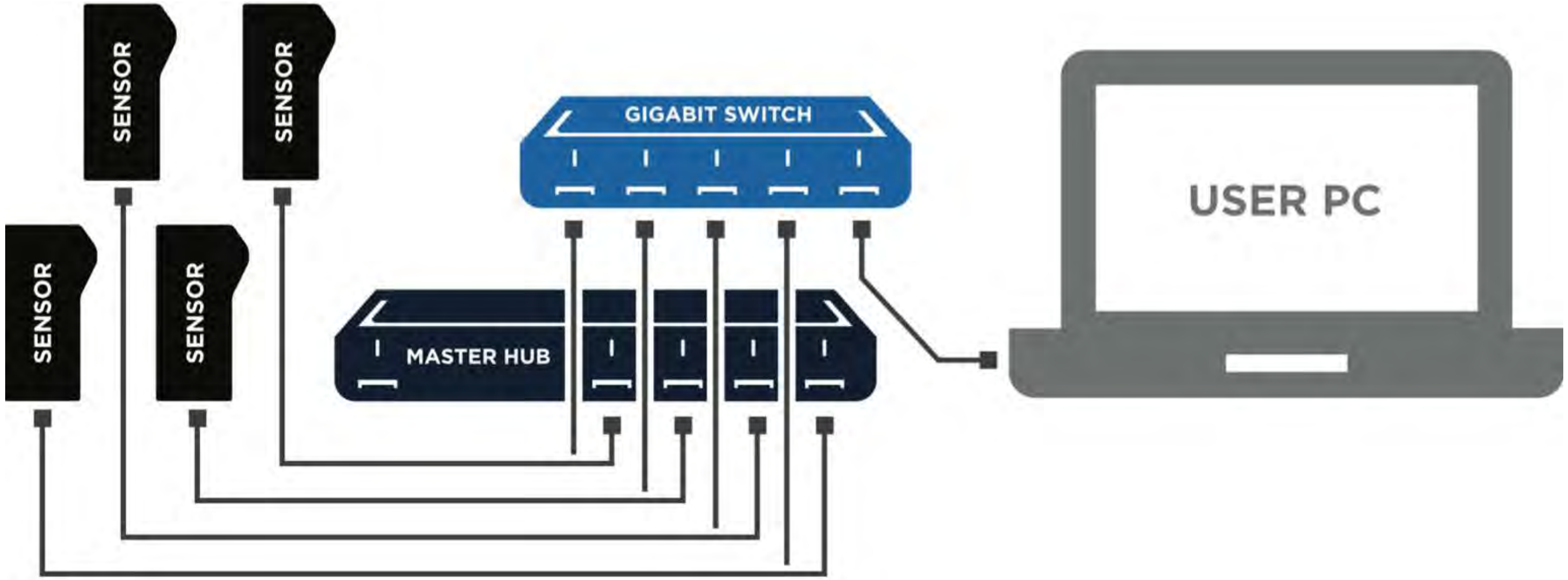
» Requires synchronization, discovery, layout, alignment, and stitching to build a dense 3D point cloud

» The latest smart 3D sensors from LMI - Gocator - provides built-in support for multi-sensor networking and full 3D feature measurement

» Increase FOV while maintaining extremely high resolution

A NETWORK OF SMART SENSORS

- In the “smart” automated factory, networked smart 3D sensors connect with factory infrastructure to report results, web browsers for diagnostics and monitoring, the Internet for upgrades, and even with other sensors to exchange or combine data
- Gocator Accelerator unpacks, stitches, and generates new point clouds with data from networked sensors



CONCLUSION

- 3D inline inspection and traditional metrology are two very different environments
- 3D Smart Sensors allow for 100% Quality Control
- With the Accelerator processes can be speed up while cycle time are reduced
- Multi-Sensor-Network allows for a wider FOV, different angles while maintaining extremely high resolution

LMI TECHNOLOGIES

IMAGING USING NEAR-FIELD MICROSCOPY AND NEAR-FIELD LITHOGRAPHY

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[3] Dept. of Physics, Faculty of Electrical Engineering, University of Žilina, Žilina

Abstract
In this contribution we presented the near-field scanning optical microscope (NSOM) as an effective tool for high resolution imaging. The NSOM uses the high resolution optical fiber probe prepared from tapered optical fibers in combination with nanoposition 3D system. The NSOM was used for characterization of the near field of light emitting diodes (LED's) with patterned submicrometer structures. The NSOM images show the submicrometer resolution of the emitted optical field from the LED's. The NSOM technique was also used for lithography of semiconductor surfaces. Using the NSOM lithography different surface patterns with submicrometer resolution were prepared in photoresist layer and GaAs surface.

Zobrazovanie pomocou **mikroskopie v blízkom poli a litografia v blízkom poli**

Dušan Pudiš

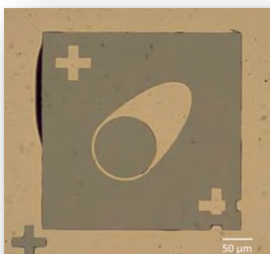
Ľ. Šušlik, I. Lettrichová
Dept. of Physics, Faculty of Electrical Engineering, University of Žilina, Slovakia

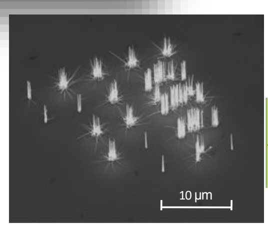
Kľúčové slová

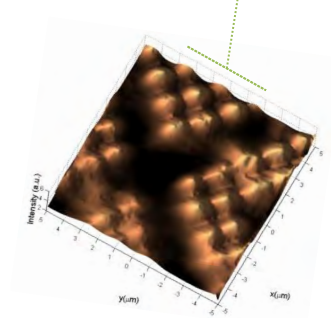
photonic crystal structure — **PhC**

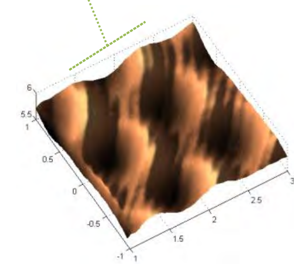
NSOM — *near-field scanning optical microscope*

- **NSOM litografia** — illumination mode
  - LED povrch
  - GaP nanodrôty
- **NSOM mikroskopia** — collection mode
  - Blízke pole LED s predefinovanou štruktúrou
  - Blízke pole periodickej LED









FOTONICKÉ KRYŠTÁLY V PRÍRODE – 1D, 2D, 3D

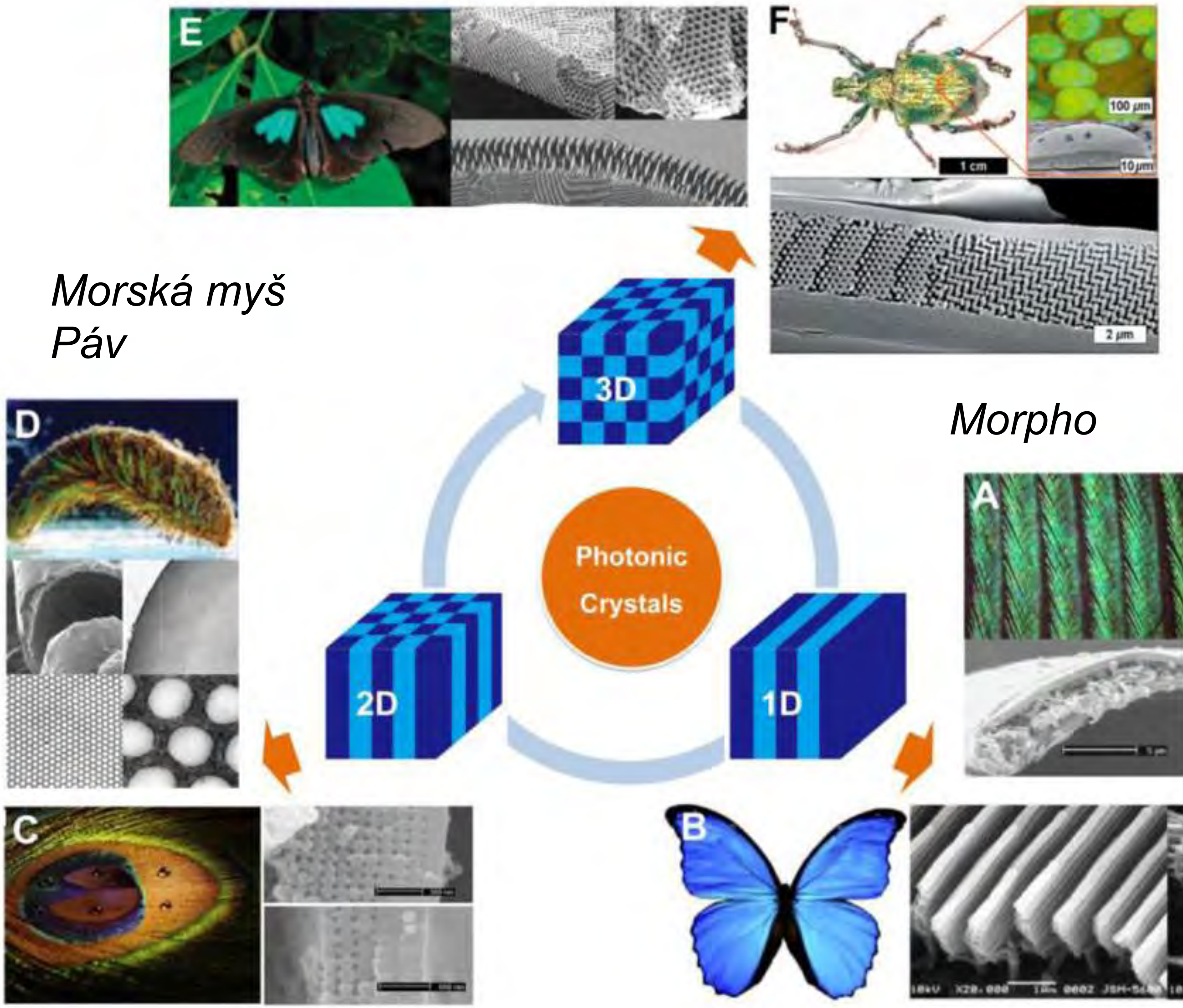
H. Wang, K. Q. Zhang, Sensors **2013**, *13*(4), 4192-4213

Paride sesostris
(3D inverzný opál)

L. augustus
(3D diamantová štruktúra)

Morská myš
Páv

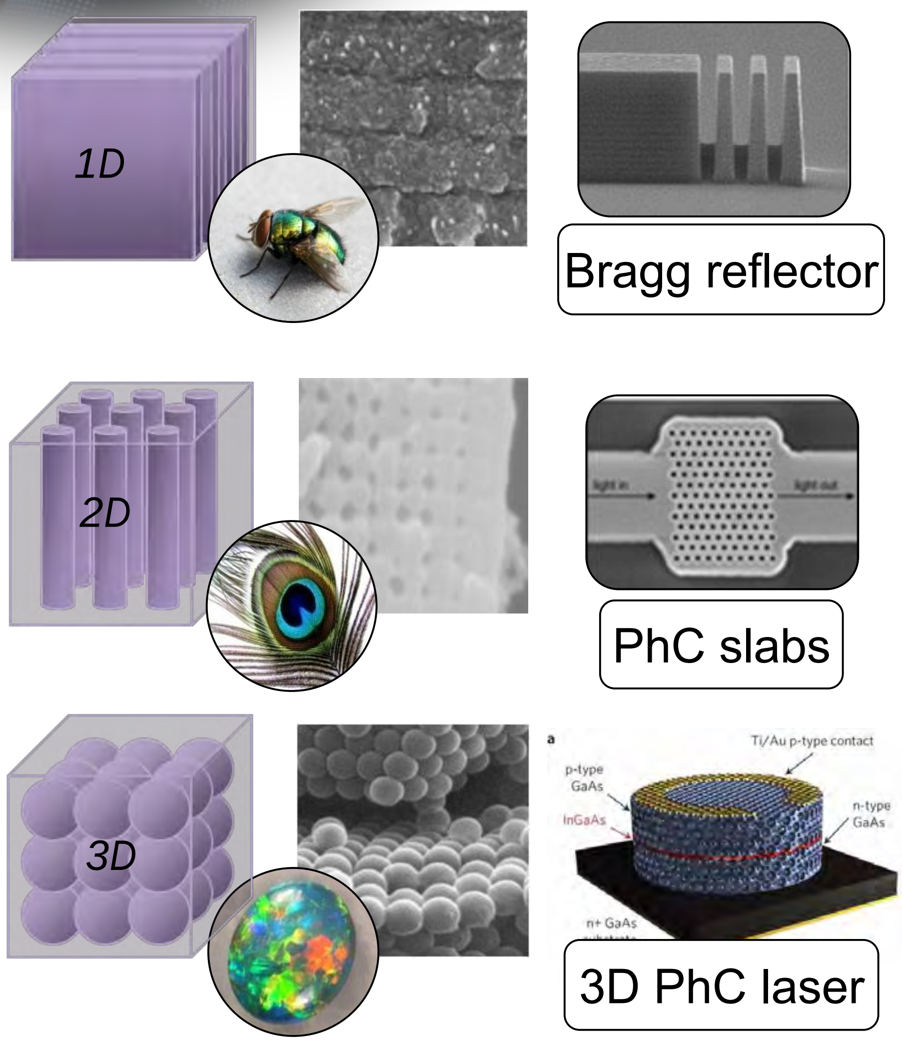
Morpho



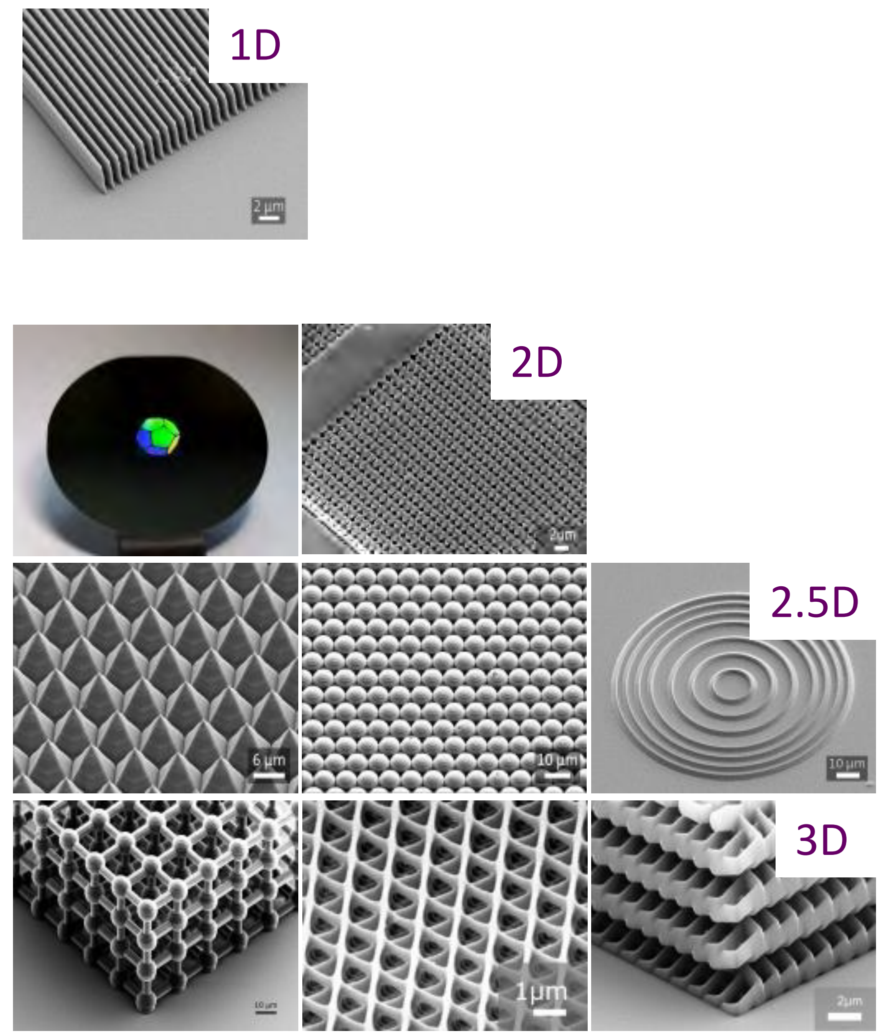
Tmesisternus isabellae
(mokrý/suchý)

FOTONICKÉ KRYŠTÁLY V TECHNOLÓGIÁCH

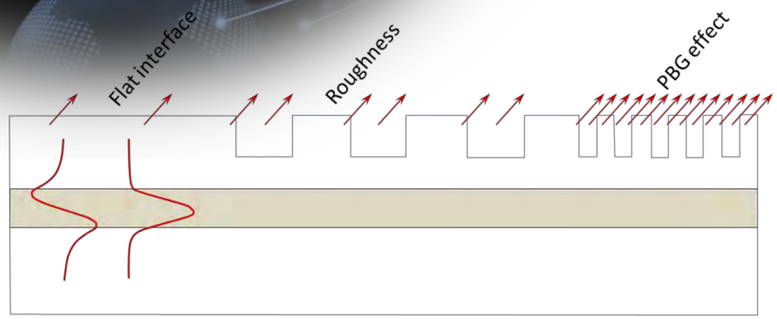
Príroda ***Technológia***



www.nanoscribe.de (Markus Thiel)

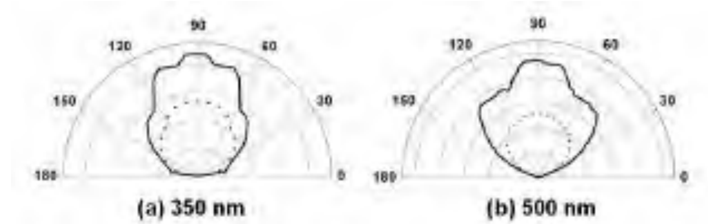


Nárast účinnosti vyžarovania ⟺ Modifikuje sa vyžarovací diagram

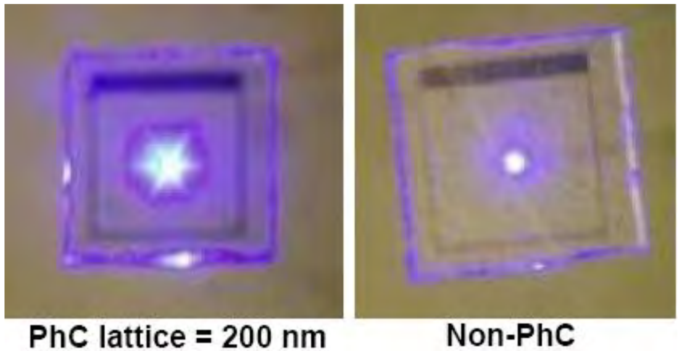


- *asi 30% žiarenia sa stráca odrazom naspäť do čipu*
- *v dôsledku PhC sa vylepší vyviazanie žiarenia*

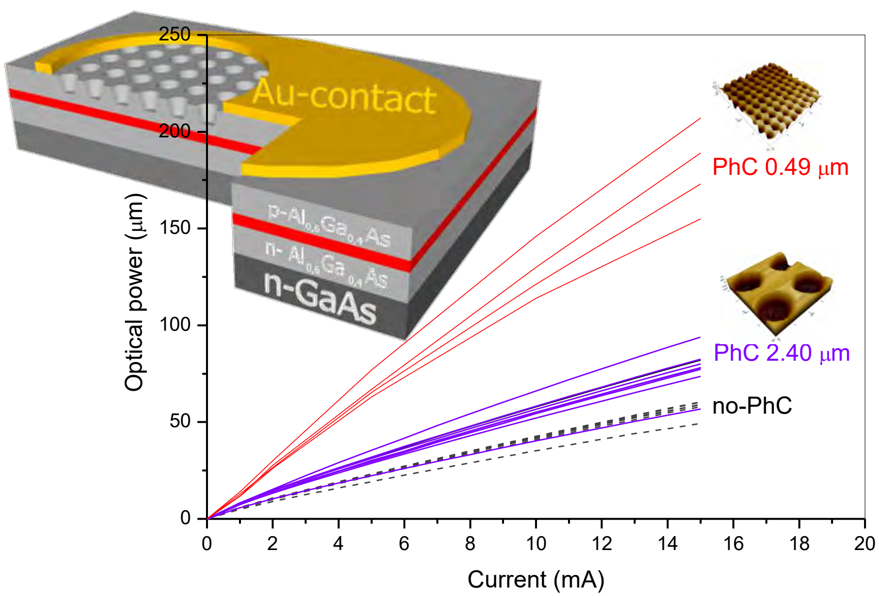
M. Charlton et al. Proc of SPIE Vol. 6486 (2007)



Y. J. Lee et al. Opt. Express 13 (15) (2005)

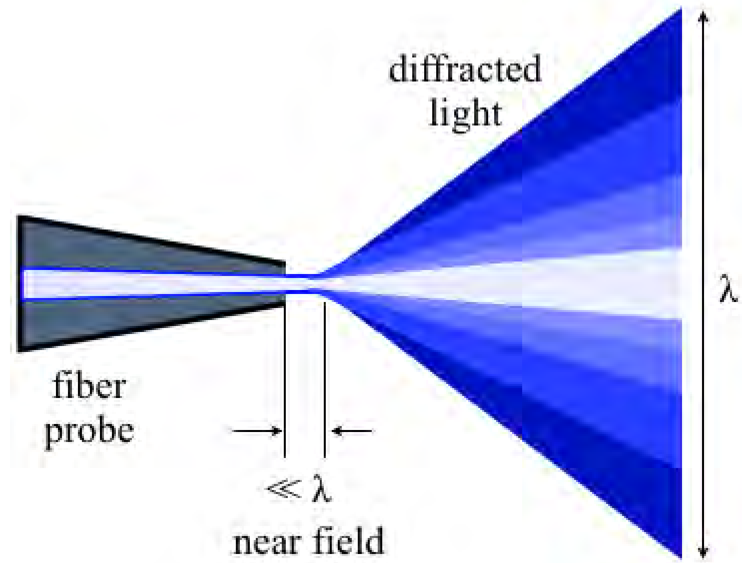


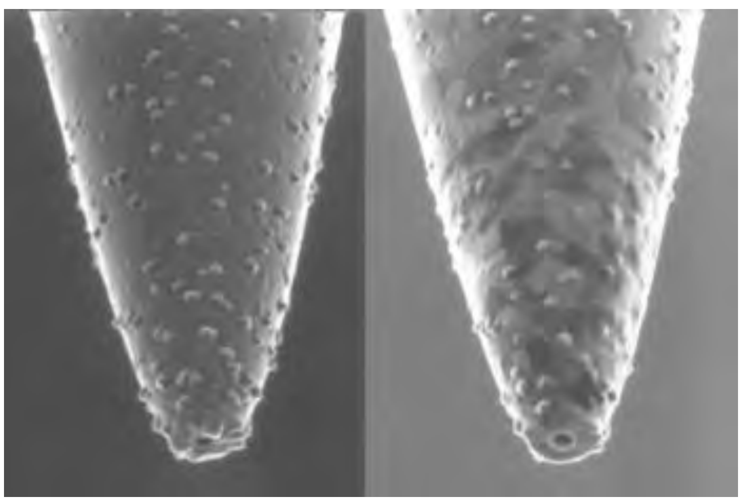
J. J. Wierer, Appl. Phys. Lett. 84, 3885 (2004)



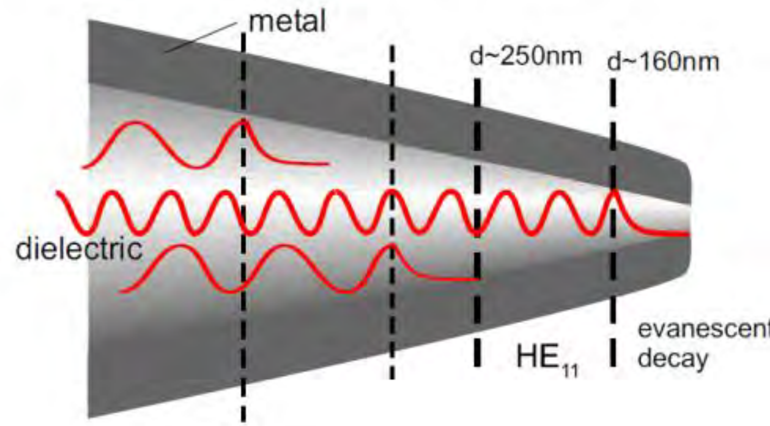
D. Pudis et al. Appl. Surf. Sci. 269, 116 (2013)

Blízke pole - pole, kde nedochádza k difrakcii (zväčša pre d<<λ)



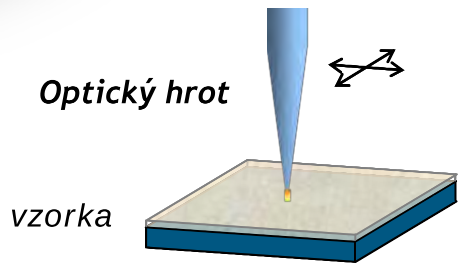


SEM obrázok pokoveného hrotu s apertúrou

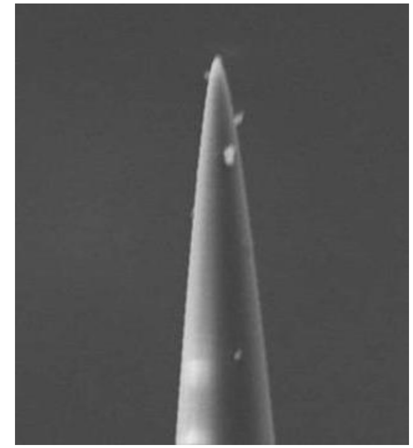


Novotny L, Hecht B. Principles of nano-optics. Cambridge University Press. New York 2006.

PRINCÍP ZOBRAZOVANIA V BLÍZKOM POLI

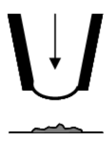


*N*ear-field
*S*canning
*O*ptical
*M*icroscope



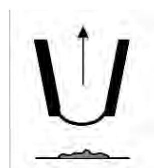
Optický hrot

Illumination mode



NSOM litografia

Collection mode

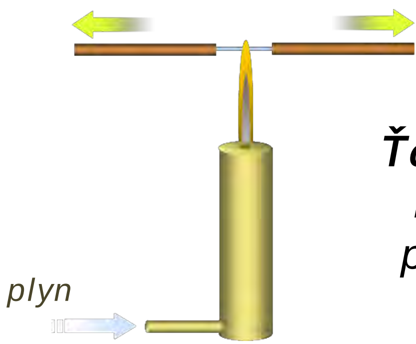


NSOM mikroskopia

v **FF mikroskopii** – Abbey difrakčné kritérium **~ vlnová dĺžka**
v **NF mikroskopii** – rozlíšenie ~ **priemer apertúry**

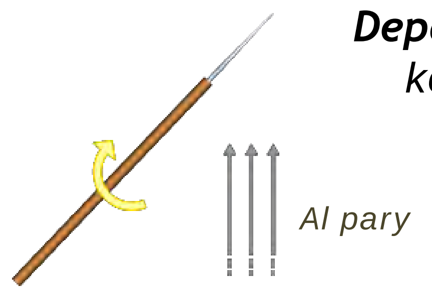
SONDY PRE BLÍZKE POLE

1.

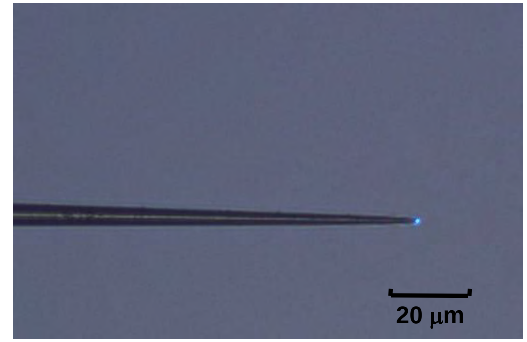


Ťahanie v *malom plameni*

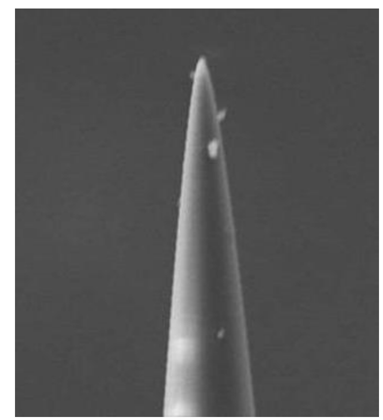
2.



Depozícia *kovu*



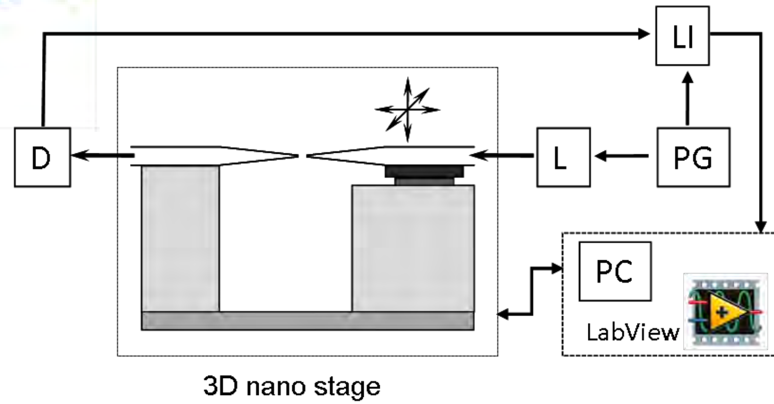
Optická sonda, obrázok optický mikroskop



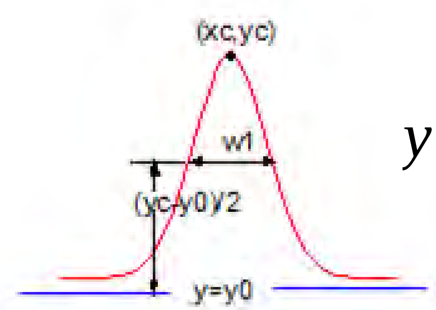
1 µm

Optická sonda, SEM obrázok

MERANIE VLASTNOSTÍ SONDY - TIP TO TIP SCAN

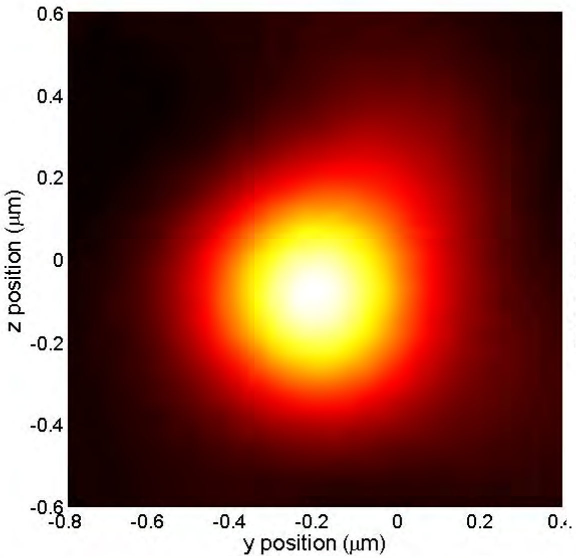


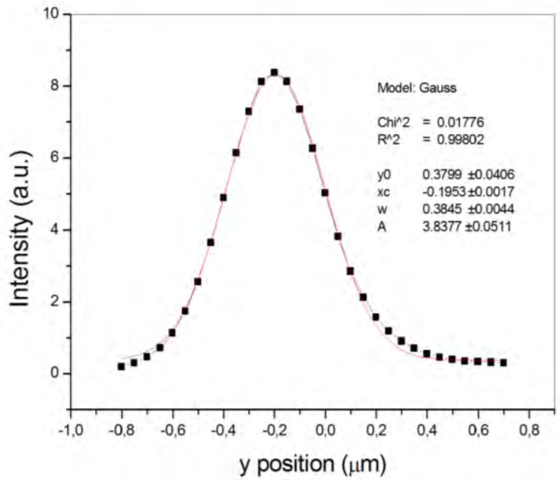
•profile of the optical near-field ~ Gaussian shape



$$y = y_0 + \frac{A}{w\sqrt{\pi/2}} e^{-2\frac{(x-x_c)^2}{w^2}}$$

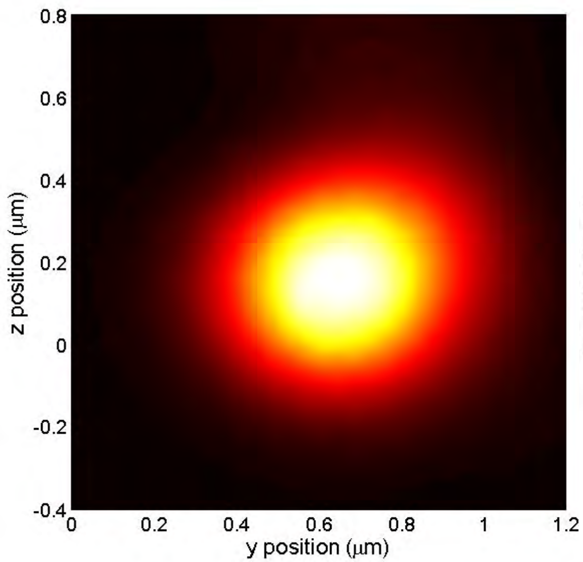
MERANIE VLASTNOSTÍ SONDY - TIP TO TIP SCAN

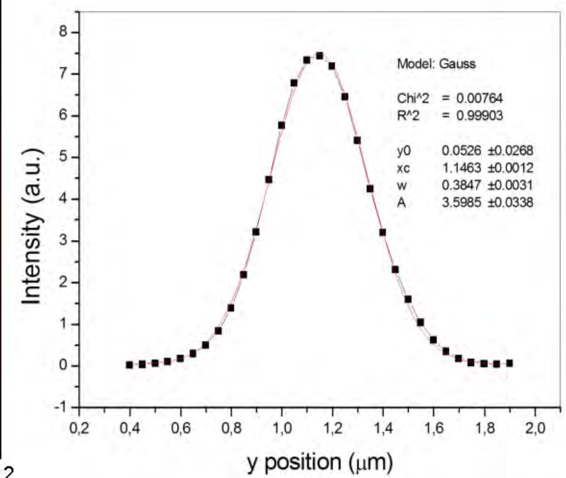




$$w_A = (384.5 \pm 4.4)\, nm$$

$$\Rightarrow FWHM_A \sim 460\ nm$$





$$w_B = (384.7 \pm 3.1)\, nm$$

$$\Rightarrow FWHM_B \sim 460\ nm$$

- **=> apertúra priemer menej ako 460 nm**

PhC

NSOM

NSOM litografia

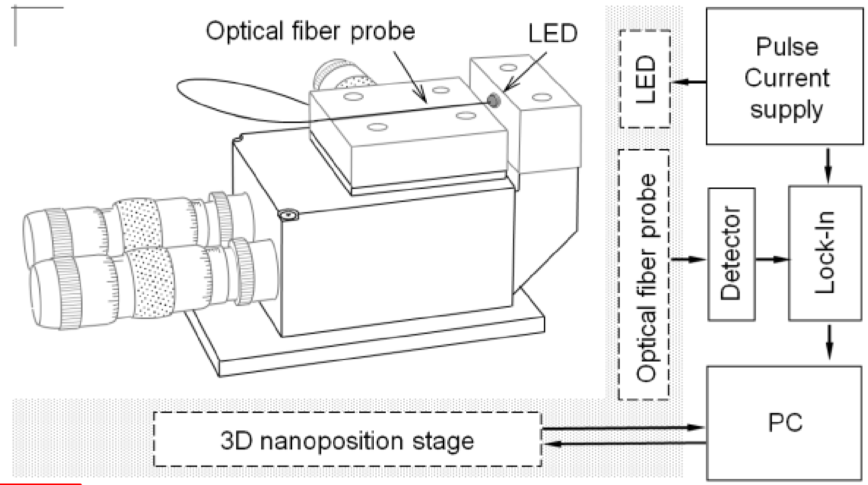
NSOM mikroskopia

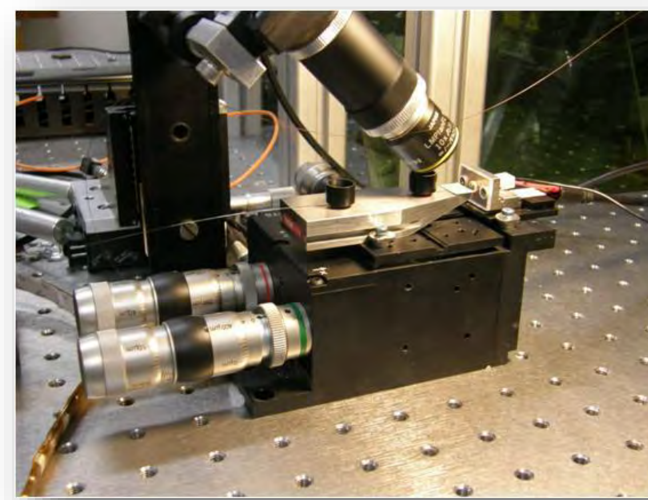
LED povrch

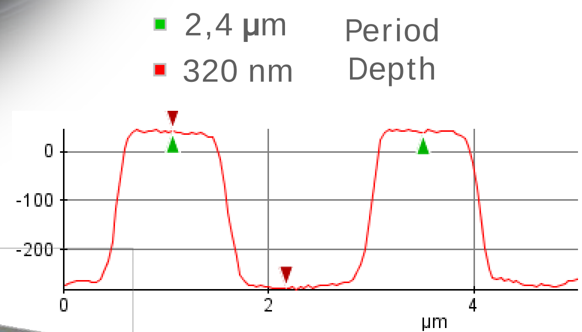
GaP nanodrôty

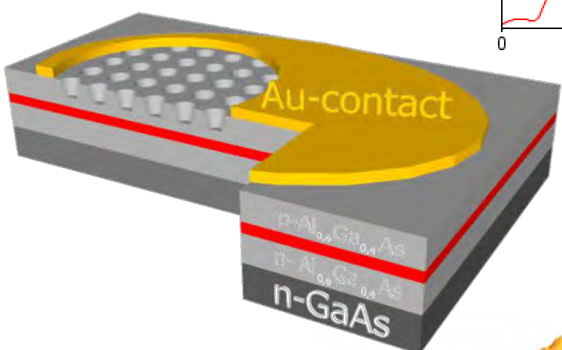
Blízke pole LED s predefinovaou štruktúrou

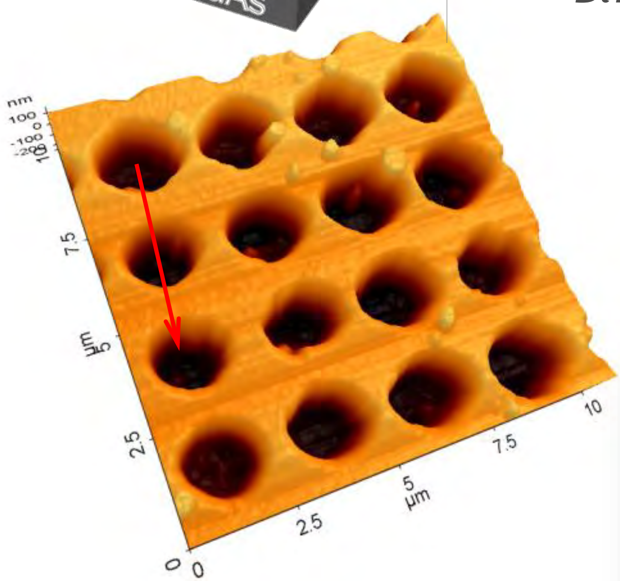
Blízke pole LED s periodickou štruktúrou



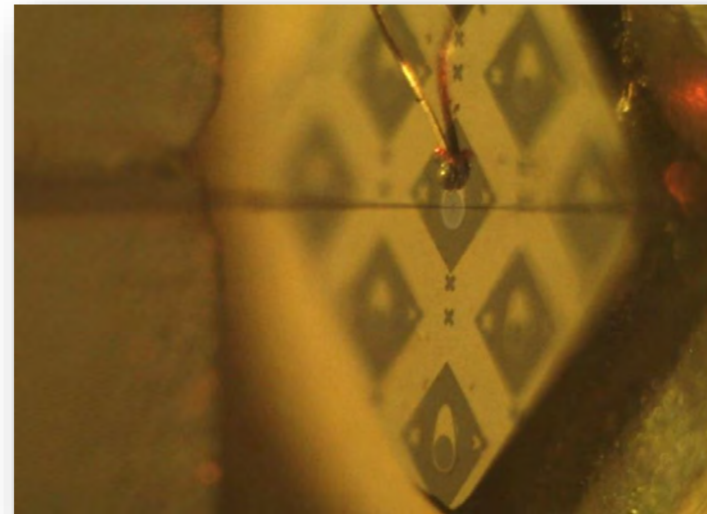




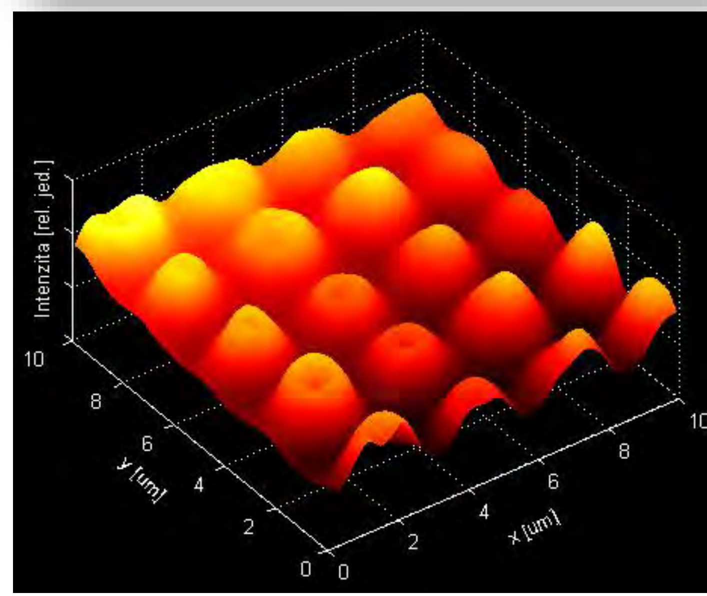


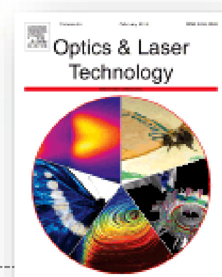


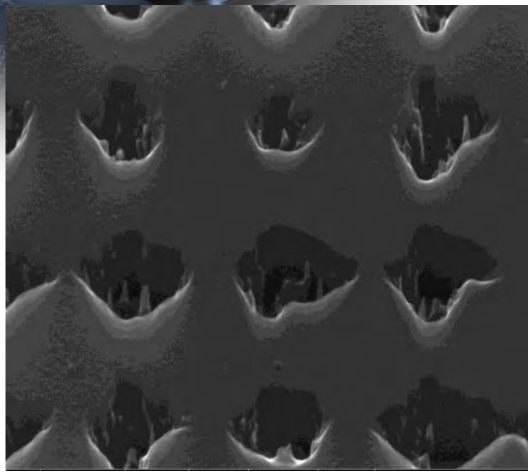
Pohľad na sondu a čip



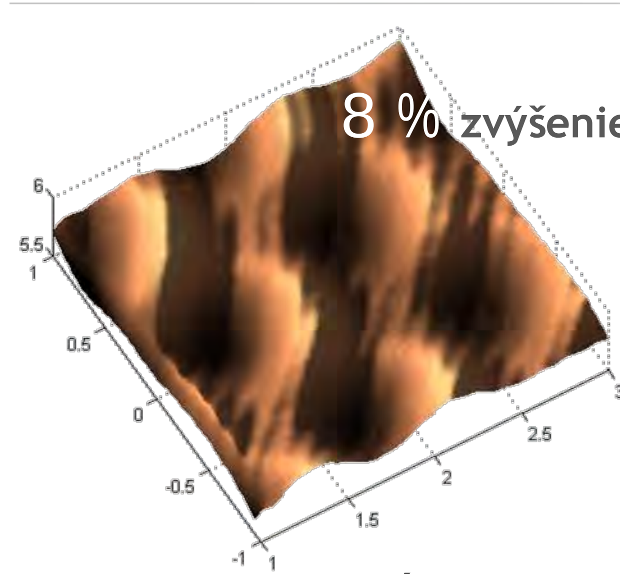
Blízke pole LED





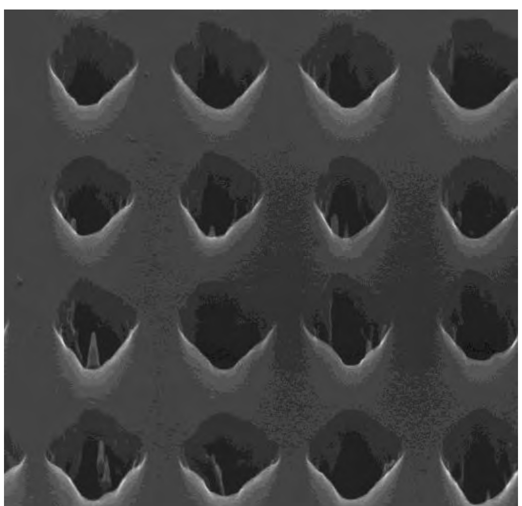


perióda
900 nm

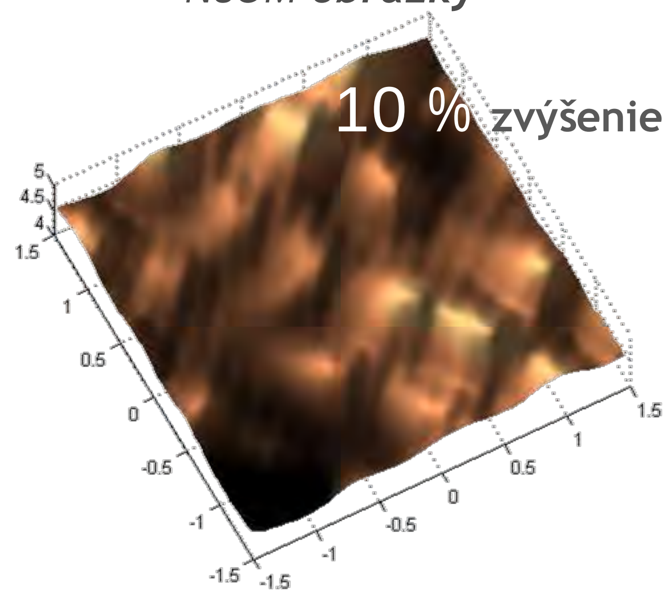


SEM ***snímky***

NSOM ***obrázky***

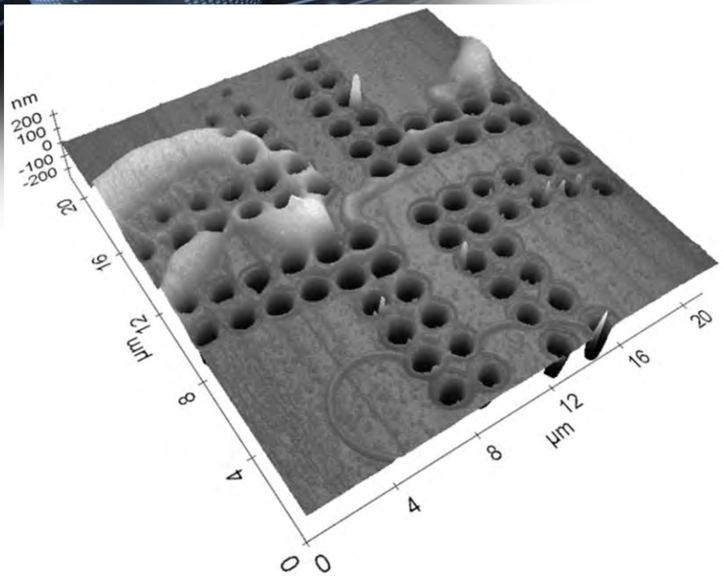


perióda
750 nm



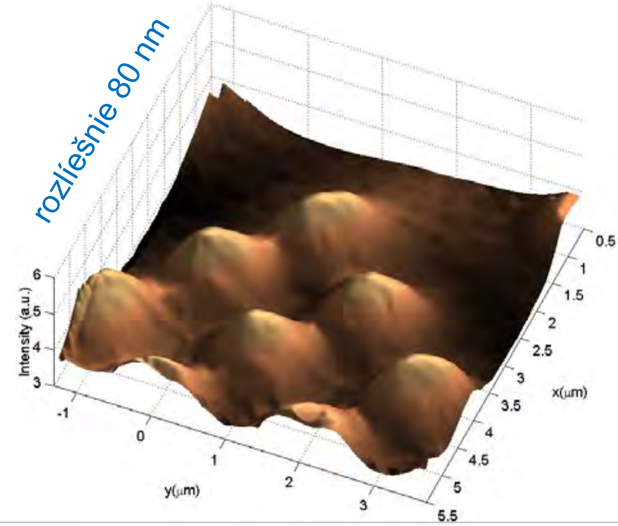
Merania blízkeho poľa LED s PhC

NSOM *obrázky*

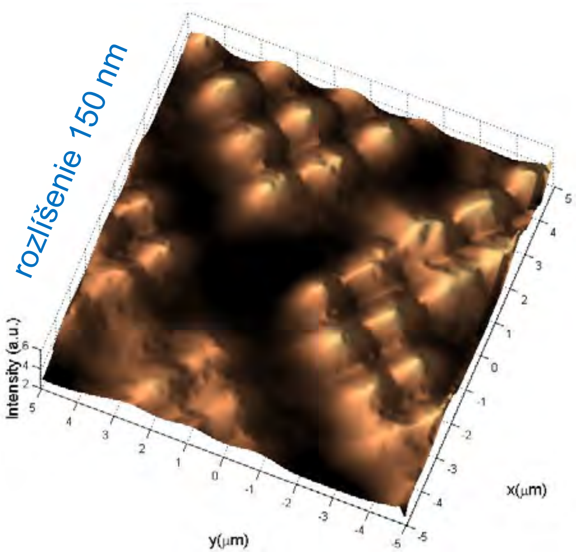


AFM povrchu tvarovanej LED

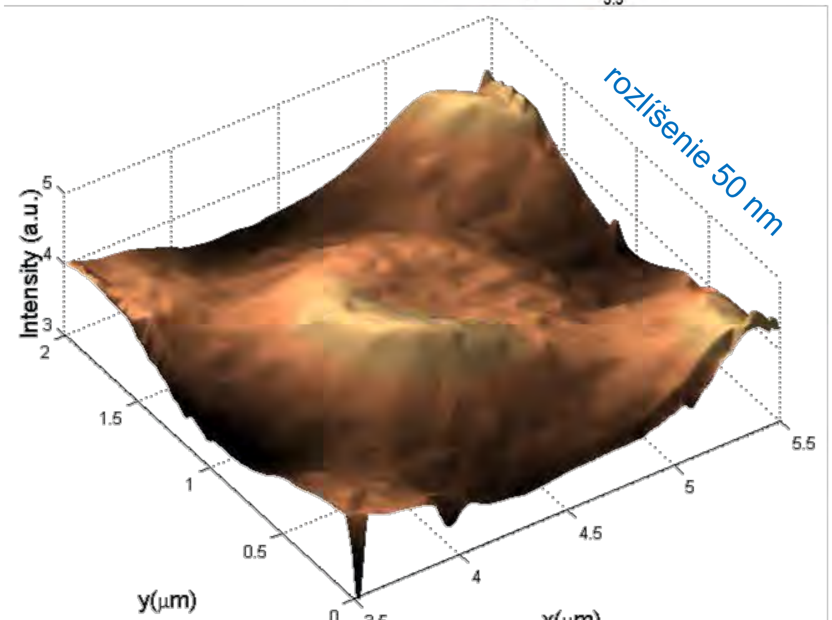
rozlíešnie 80 nm

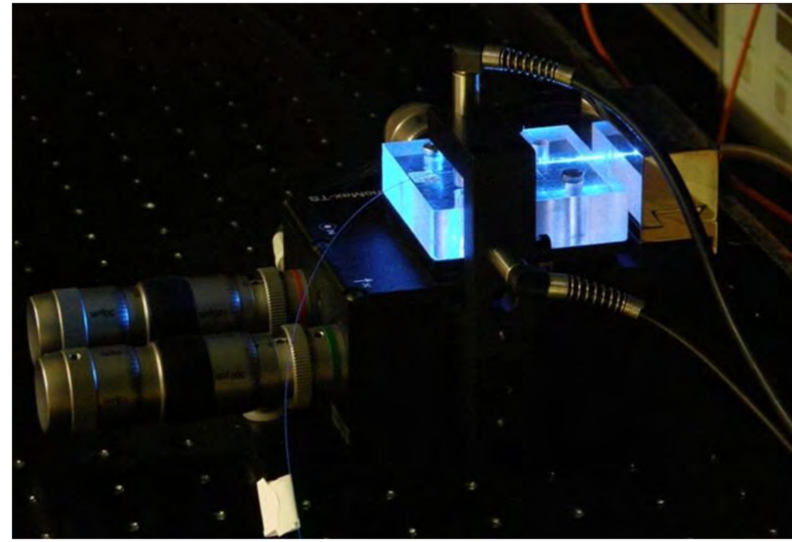


rozlíšenie 150 nm



rozlíšenie 50 nm





PhC

NSOM

NSOM litografia

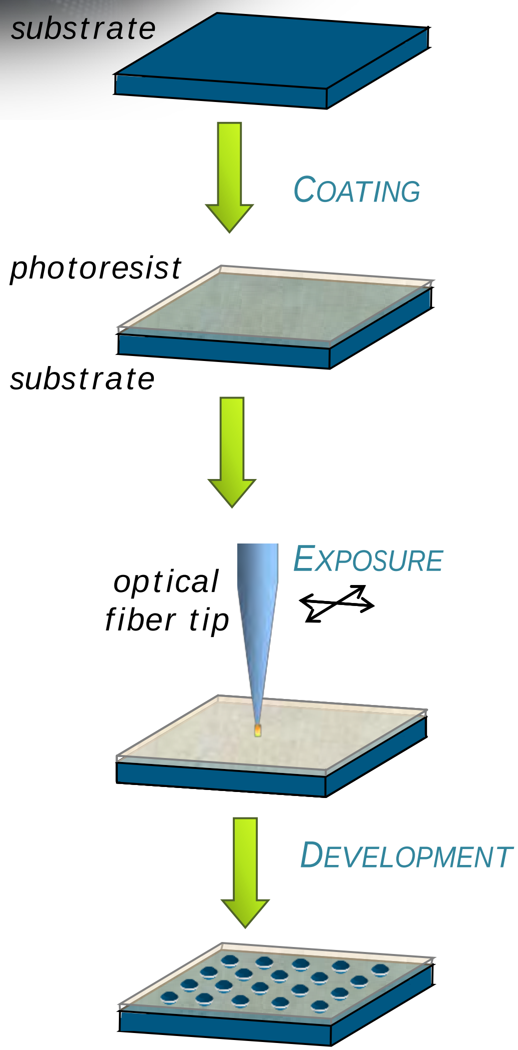
NSOM mikroskopia

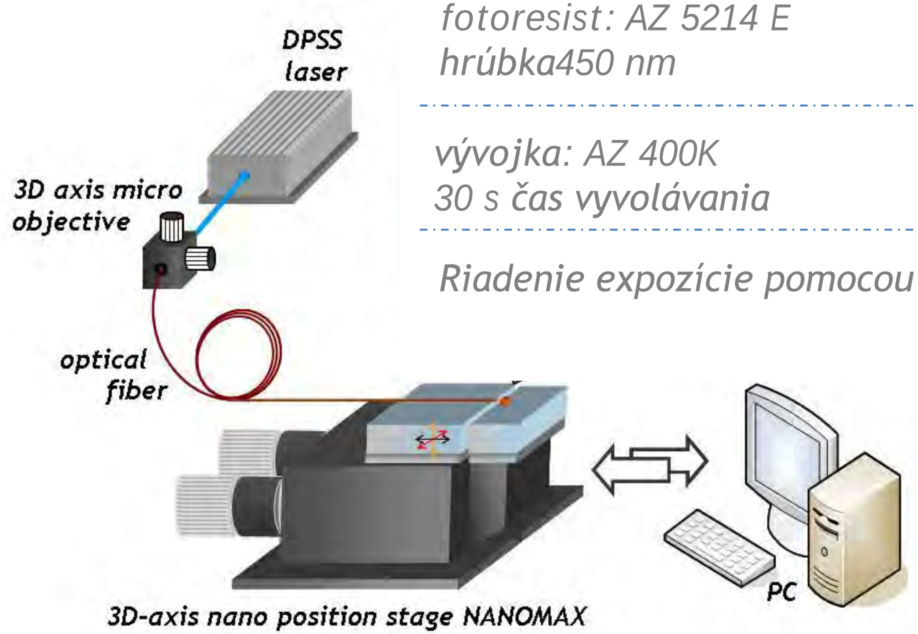
LED povrch

GaP nanowires

Blízke pole LED s predefinovanou štruktúrou

Blízke pole LED s periodickou štruktúrou





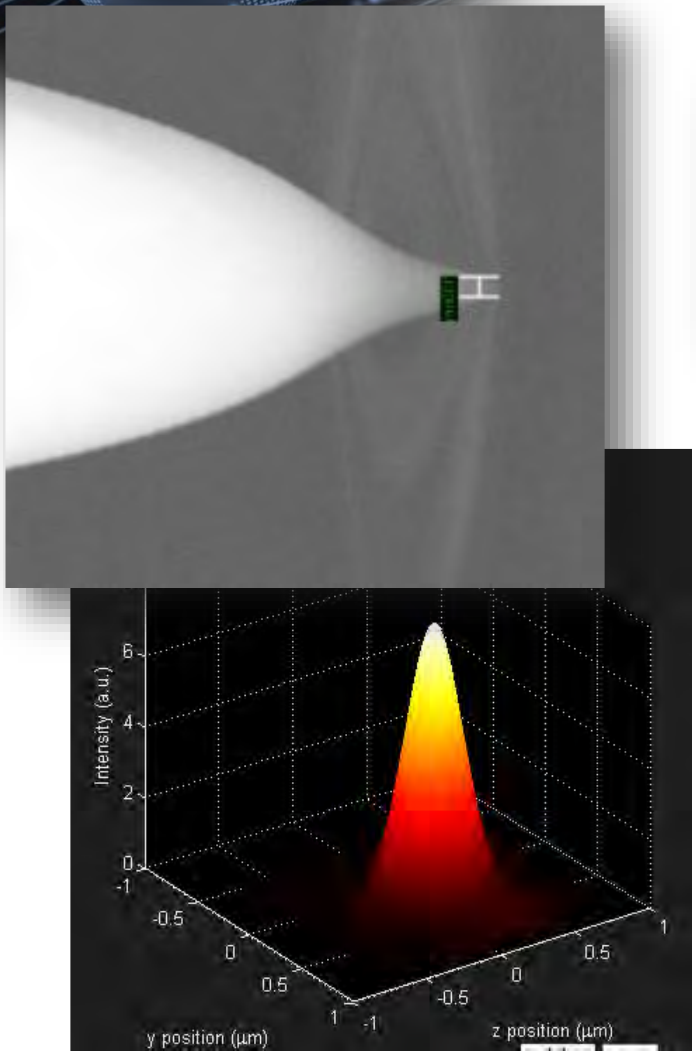
Polomer krivosti hrotu (sondy) < 500 nm

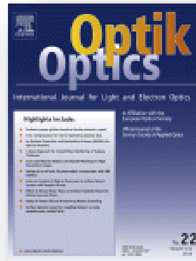
Vlnová dĺžka 473 nm

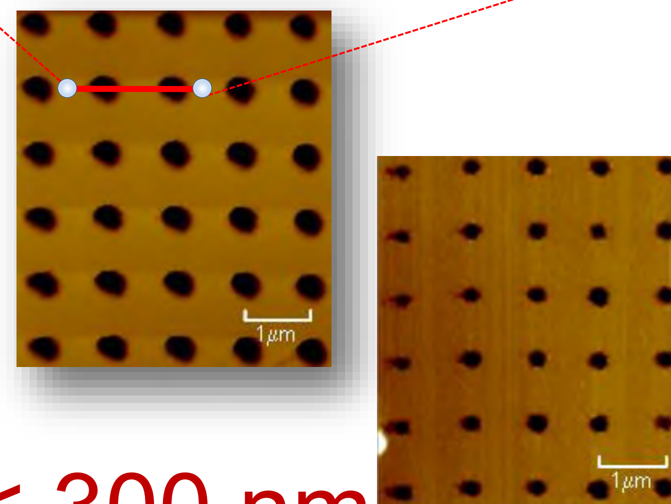
fotoresist: AZ 5214 E
hrúbka450 nm

vývojka: AZ 400K
30 s čas vyvolávania

Riadenie expozície pomocou PC



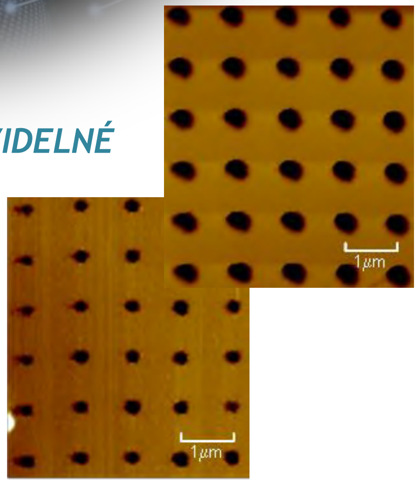




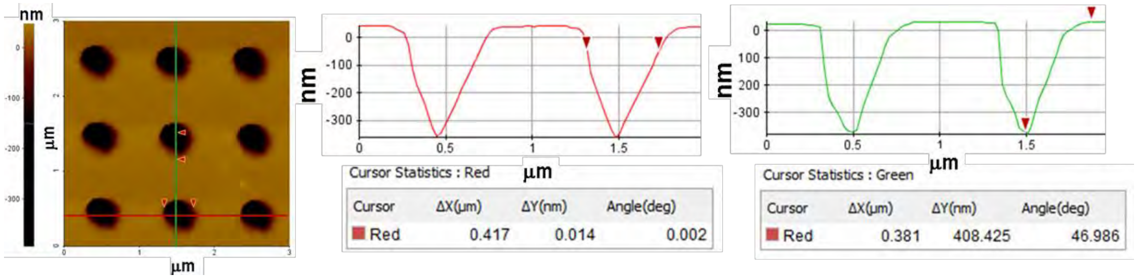
< 300 nm

I. Kubicova, D. Pudis, et al. Optik 124 1971-1973 (2013)

PRAVIDELNÉ

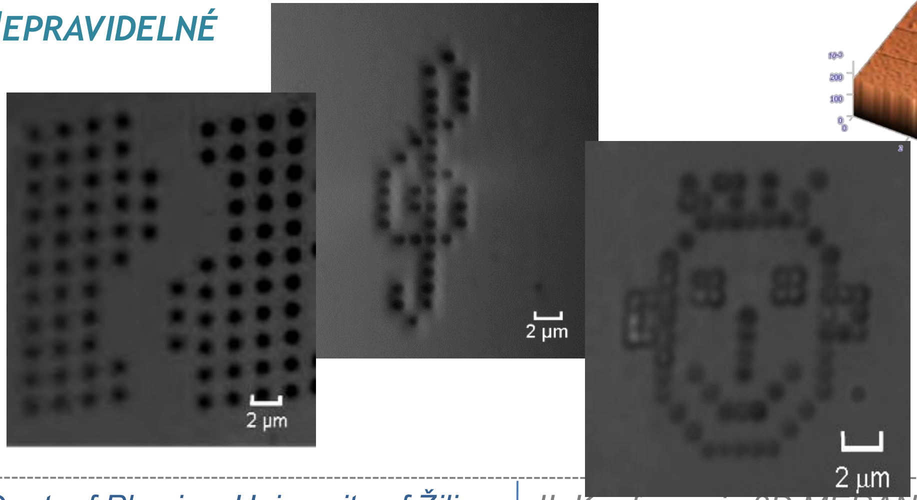


AFM OBRÁZKY A PROFIL

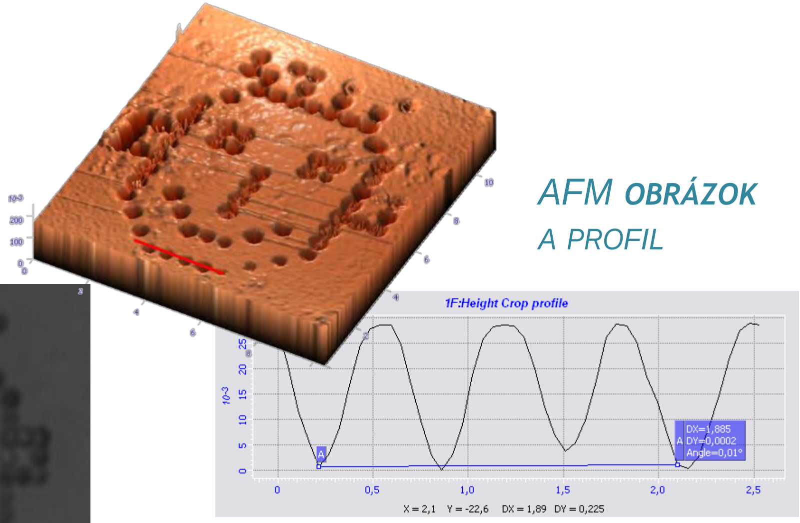


NEPRAVIDELNÉ

OPTICKÝ MIKROSKOP - OBRÁZKY

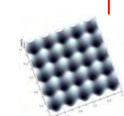


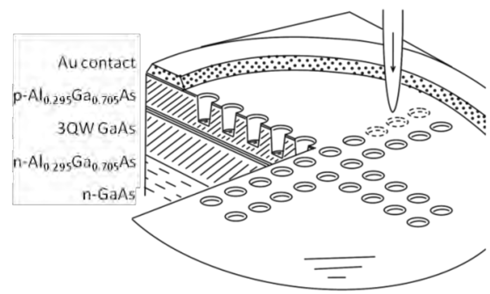
AFM OBRÁZOK A PROFIL



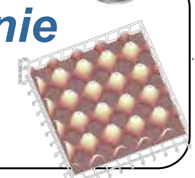
1 Depozícia
fotoresist
AZ5214E

2 Expozícia
NSOM litografia

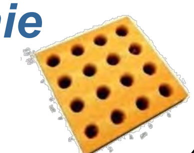




3 Vyvolanie
vývojka
AZ 400K

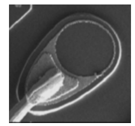


4 Leptanie
RIE

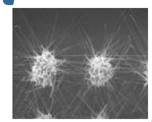


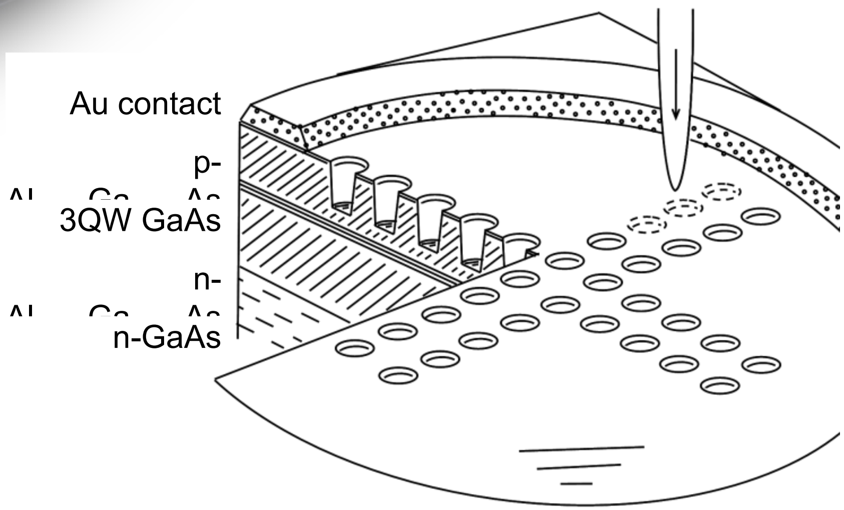
4 Au naparenie
Lift-off

5 Kontakty

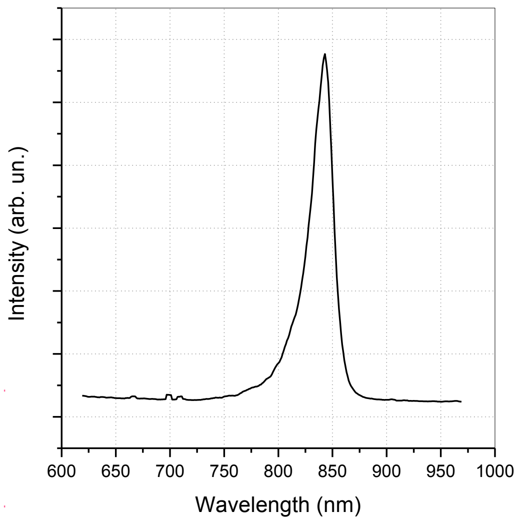


5 NWs rast



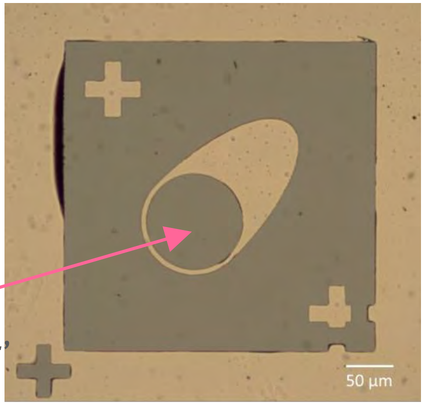


SPEKTRÁLNA CHARAKTERISTIKA **LED**



λ = 845 nm

OBRÁZOK Z OPT. MIKROSKOPU



Emitujúca časť

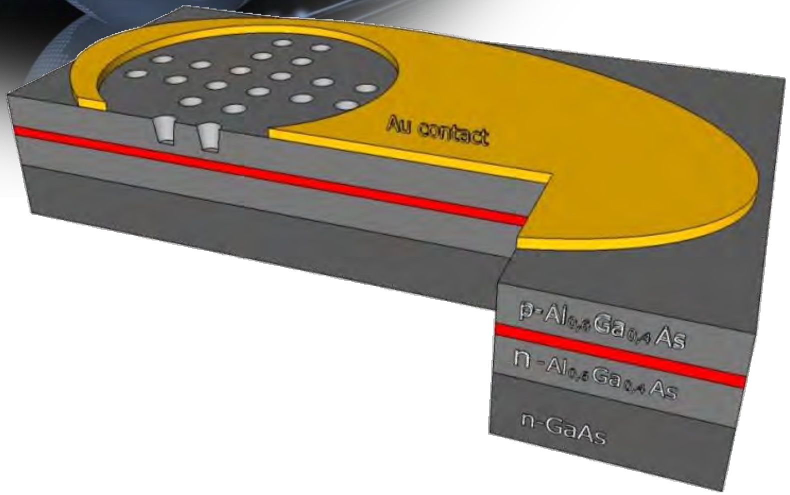
fotoresist: AZ 5214 E
Hrúbka 450 nm

vývojka: AZ 400K
30 s čas vyvolania

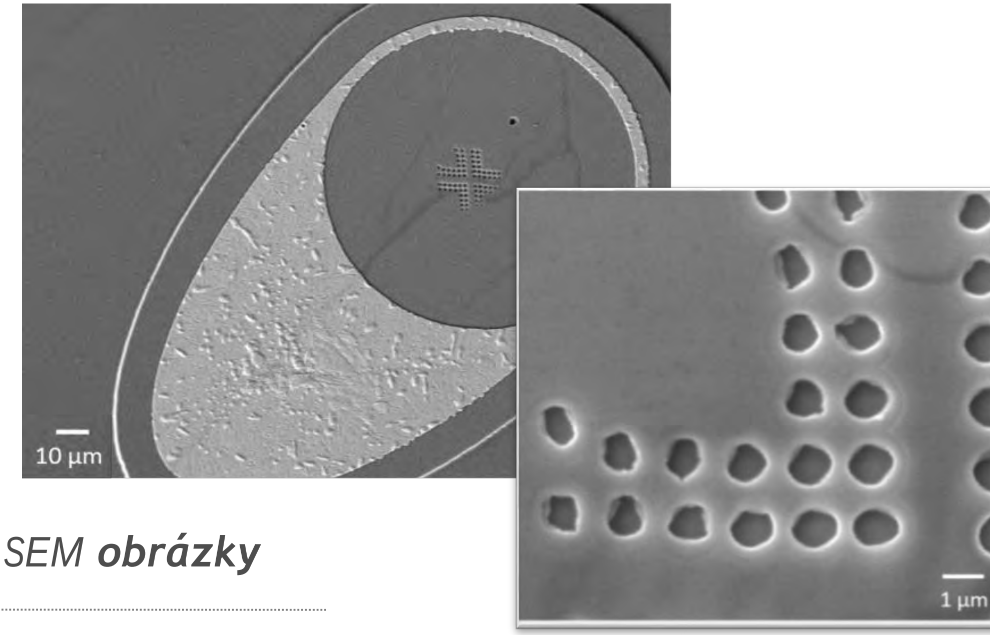
exposure control by PC

20x20 µm plocha

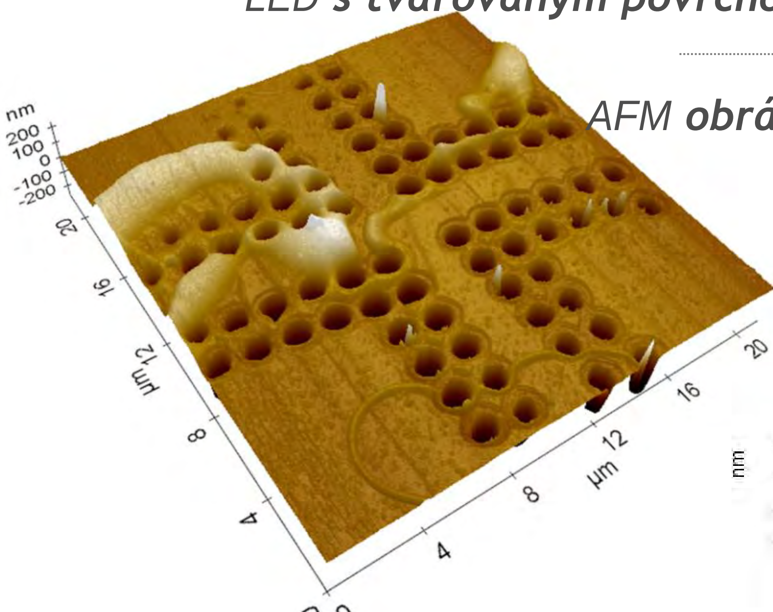
Ľubovoľný dizajn



*LED **s tvarovaným povrchom***



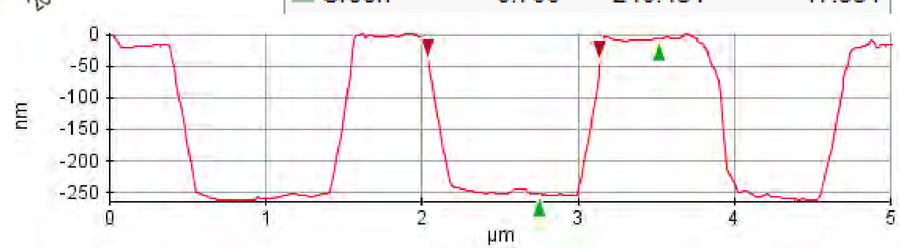
*SEM **obrázky***

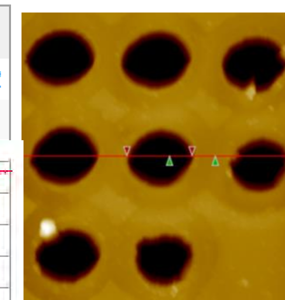


*AFM **obrázok***

AFM profil

Cursor	ΔX(µm)	ΔY(nm)	Angle(deg)
Red	1.099	-3.497	-0.182
Green	0.766	246.431	17.831

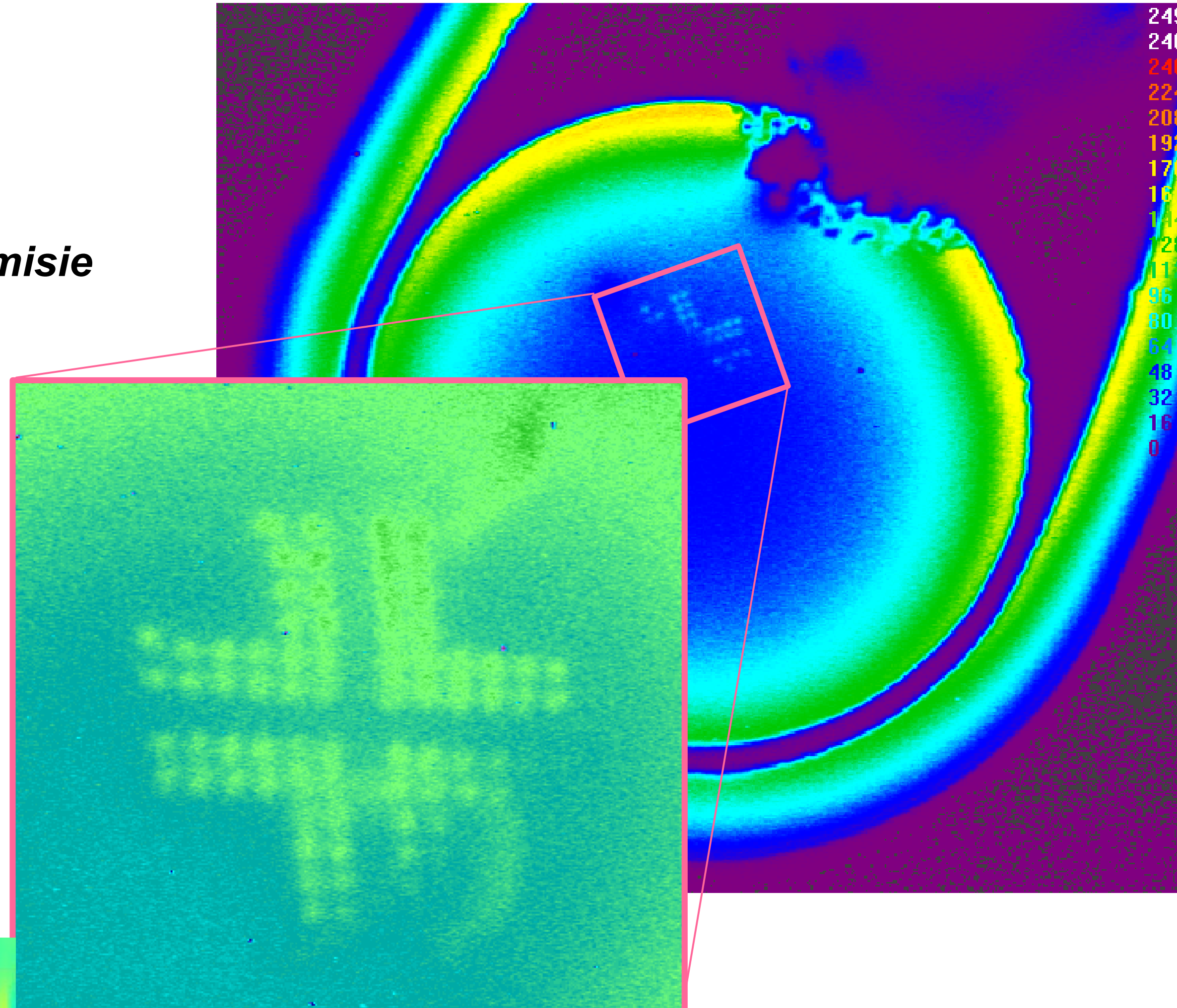




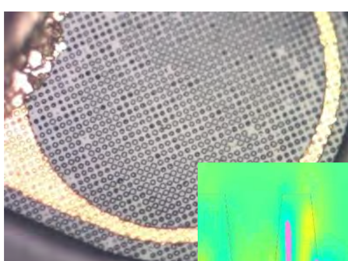
LED pri prúde 6 mA

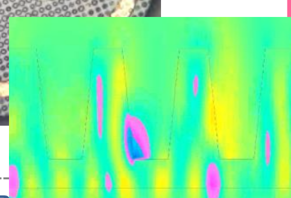
Lokálne zvýšenie emisie

~ 1.4 – 1.6 x

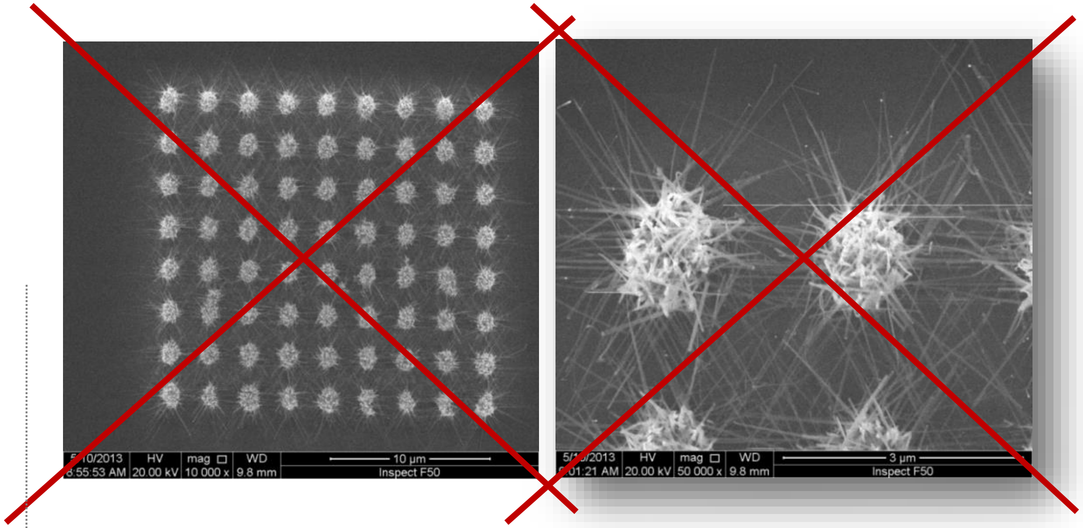


Porovnateľné s
pravidelnou štruktúrou



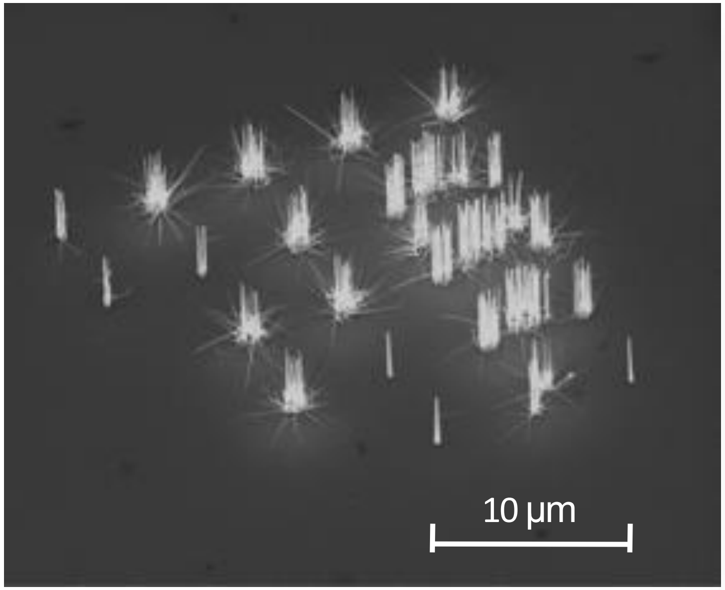


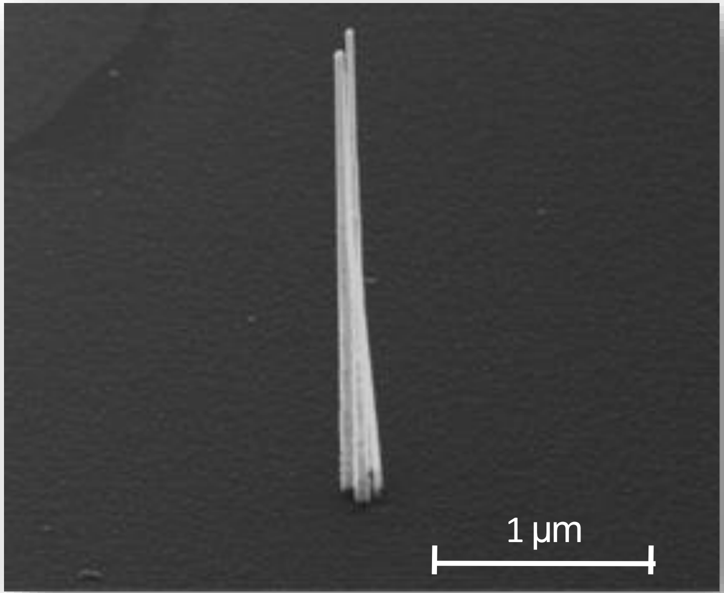
Hedhog-like structures



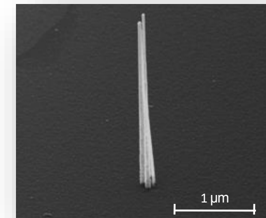
Organized NWs

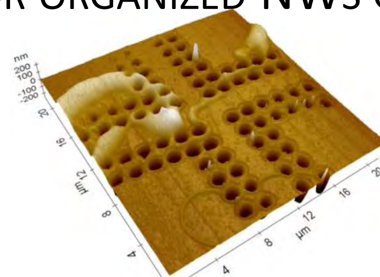
Small stack of NWs

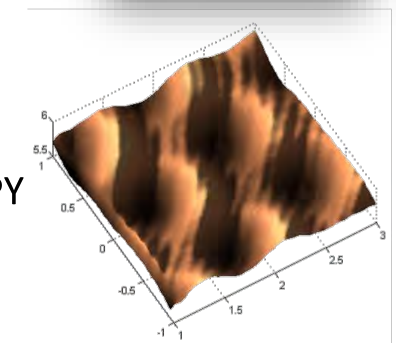




- Patterning using NSOM lithography
- 2D predefined structures for organized NWs growth
- LED structure patterning
- Near-field characterization using NSOM microscopy







NSOM - High resolution lithography and microscopy < 200 nm

Described research was supported by the Slovak National Grant Agency under the projects No. VEGA 1/0491/14 and 1/0278/15 and the Slovak Research and Development Agency under the project No. APVV 0395-12.

PERFORMANCE IN NANOSPACE

Hana Tesařová [1]
[1] Tescan Orsay Holding a.s., Brno

Abstract

TESCAN is one of the global suppliers of scientific instruments. The company is building its reputation and brand name in the field of designing and manufacturing scanning electron microscopes and system solutions for different applications. With many important patents and innovations some unique solutions and applications were established with the Scanning electron microscopes and Focused ion beam scanning electron microscopes.

TESCAN
PERFORMANCE IN NANOSPACE

PERFORMANCE IN NANOSPACE

3D Measurement and Imaging – Imaging and Advanced Diagnostic Methods in Industrial Practice

Hana Tesařová, Ph.D.

Head of Global Materials Science Applications

TESCAN – Timeline of growth and expansion

- **1991** – TESCAN, s.r.o. established
- **1999** – VEGA SEM introduced
- **2005** – MIRA Schottky FE-SEM introduced
- **2007** – LYRA FIB-SEM introduced
- **2009** – Chinese branch established
- **2010** – Acquisition of TESCAN USA; Third generation of TESCAN SEMs introduced
- **2011** – FERA3 and TIMA introduced; 1000 SEM installed & ISO certification
- **2012** – MIRA3 AMU introduced
- **2013** – Merger of TESCAN and ORSAY PHYSICS resulted in TESCAN ORSAY HOLDING, a.s.; TESCAN-UK Ltd. established
- **2014** – Acquisition of App Five; GAIA3 and RISE introduced
- **2015** – XEIA3 and Q-PHASE introduced; TESCAN Benelux + TESCAN Do Brasil established
- **2016** – NEW UHR Series Triglav™
- **2017** – S8000G introduced

TESCAN

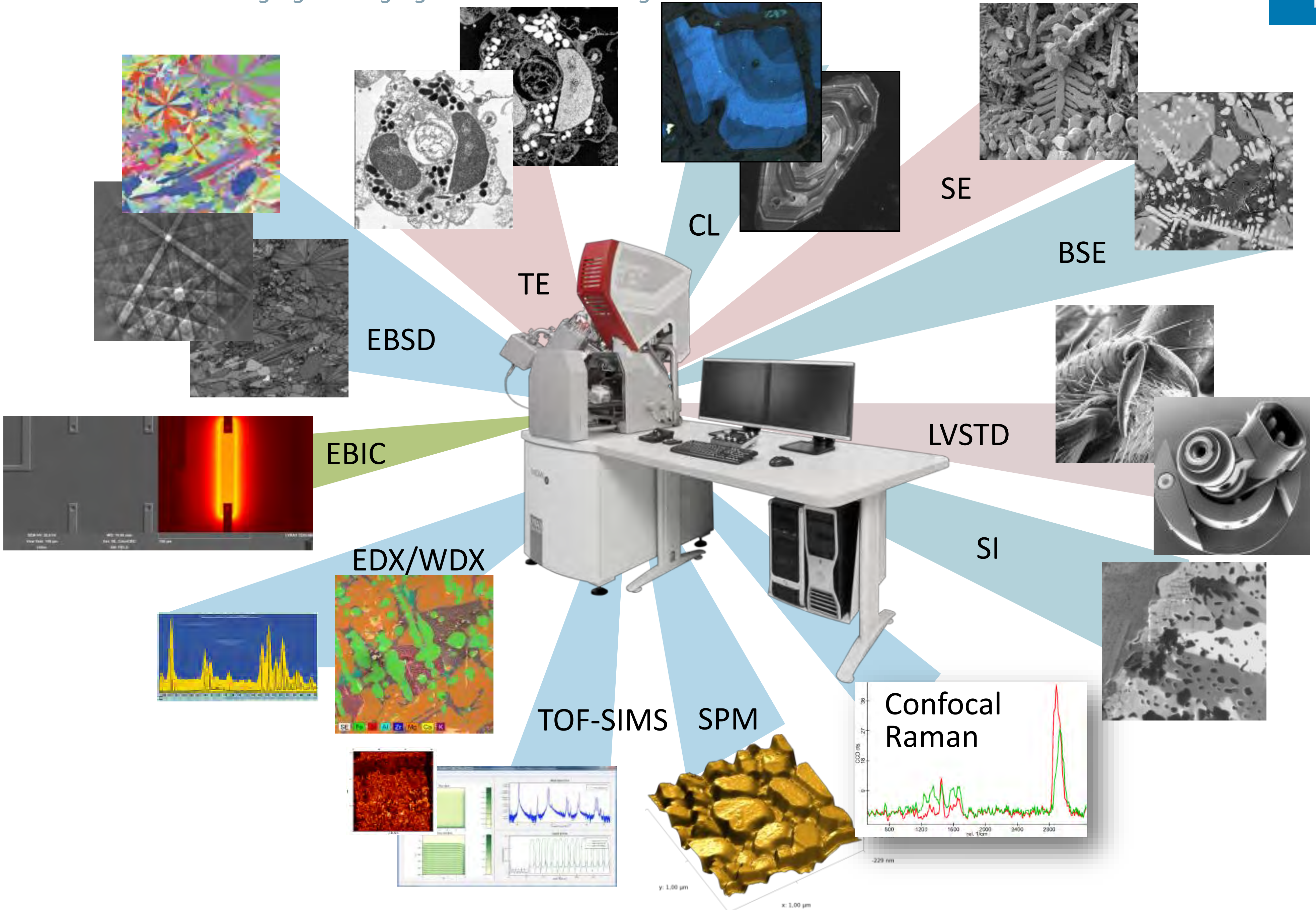
- 450 Holding Employees Globally
- Subsidiaries
- Business Mergers / Acquired Companies
- Independent Distribution Network

- Tescan Brno
- Tescan UK
- Tescan USA
- Tescan China
- Tescan Benelux
- Tescan France
- Tescan do Brasil

- Tescan Analytics
- Tescan Tempe
- Tescan Analytics

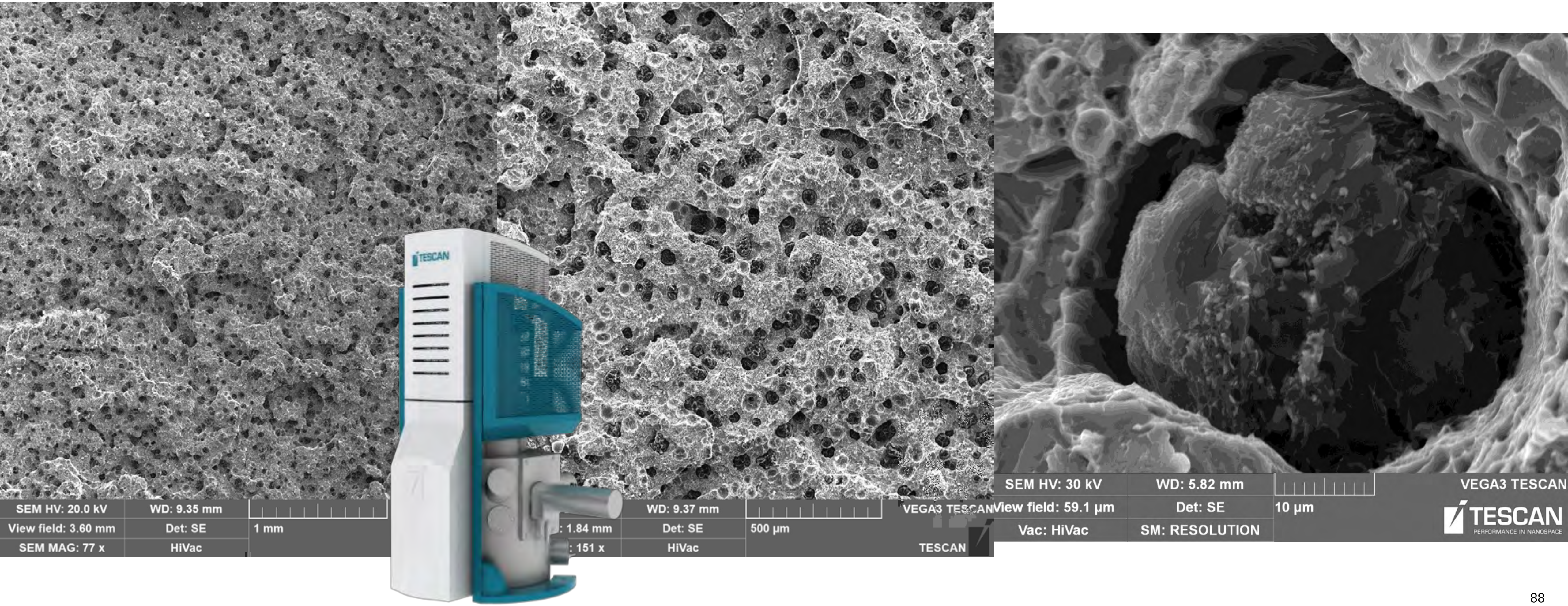
TESCAN Brno, s.r.o.

TESCAN ORSAY HOLDING, a.s.


EBSD
TE
CL
SE
BSE
EBIC
LVSTD
SI
EDX/WDX
TOF-SIMS
SPM
Confocal
Raman

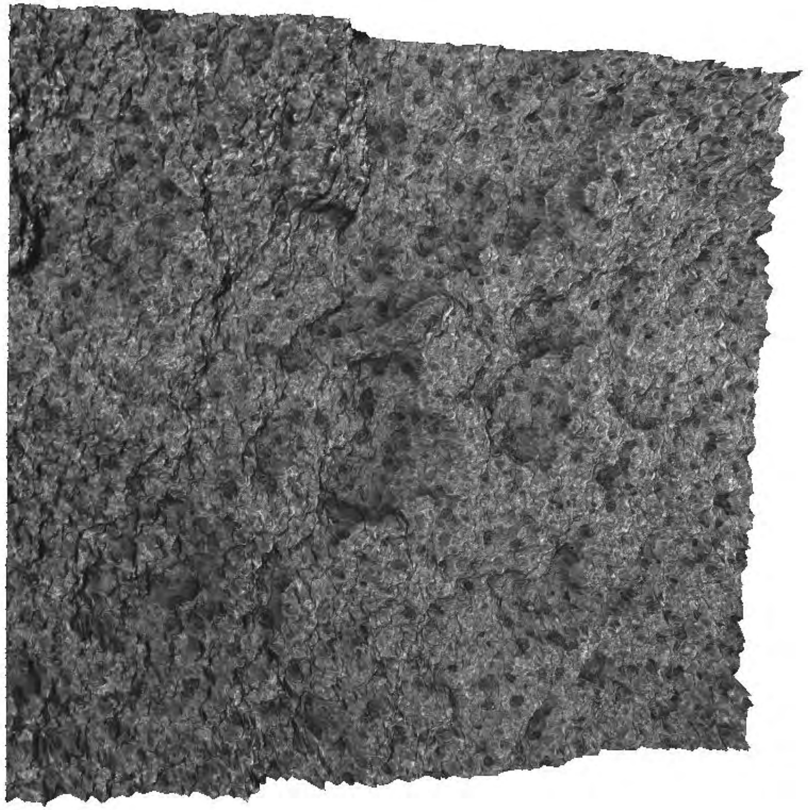
VEGA – Application Examples

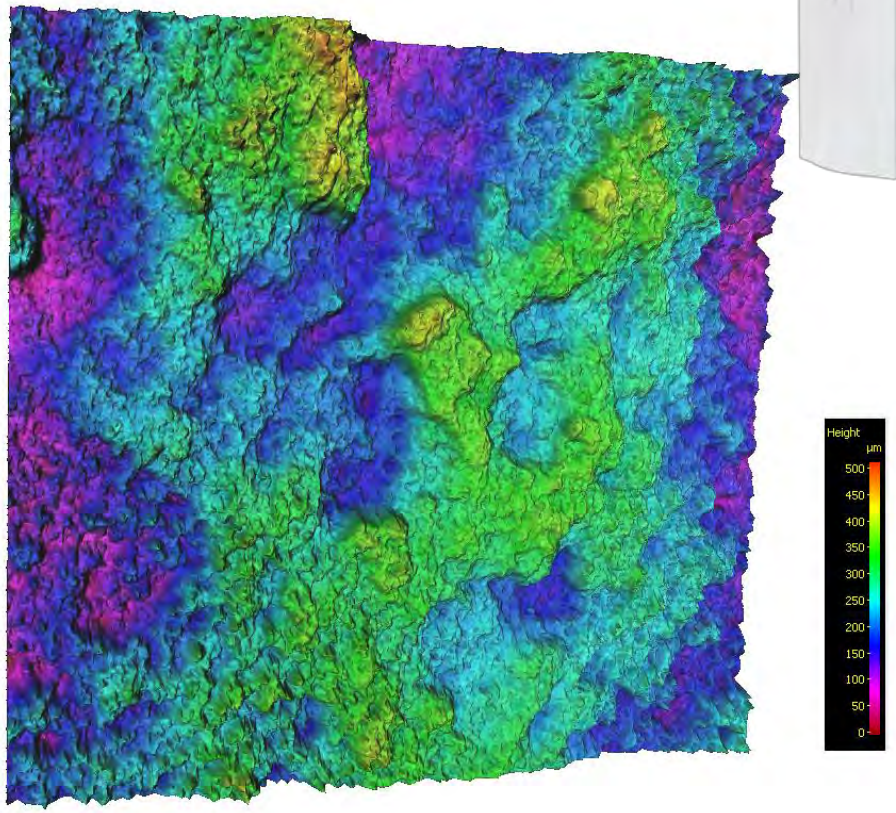
- **Austempered Ductile Cast Iron – Fracture Surface**

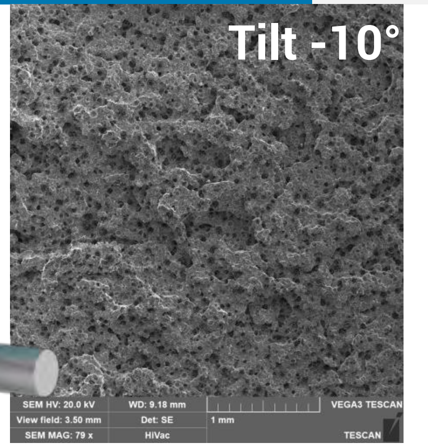


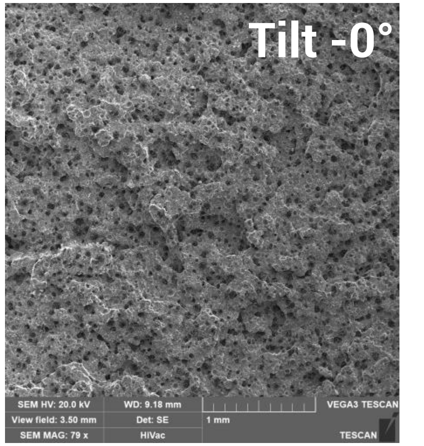
VEGA – Application Examples

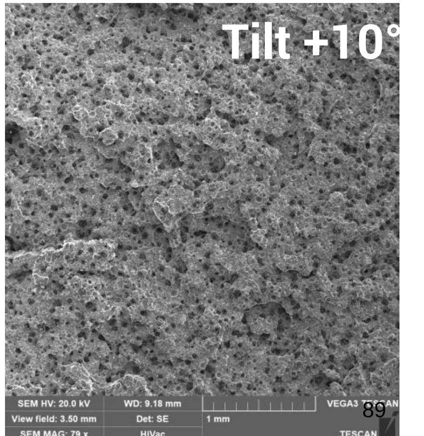
- **Austempered Ductile Cast Iron – Fracture Surface**







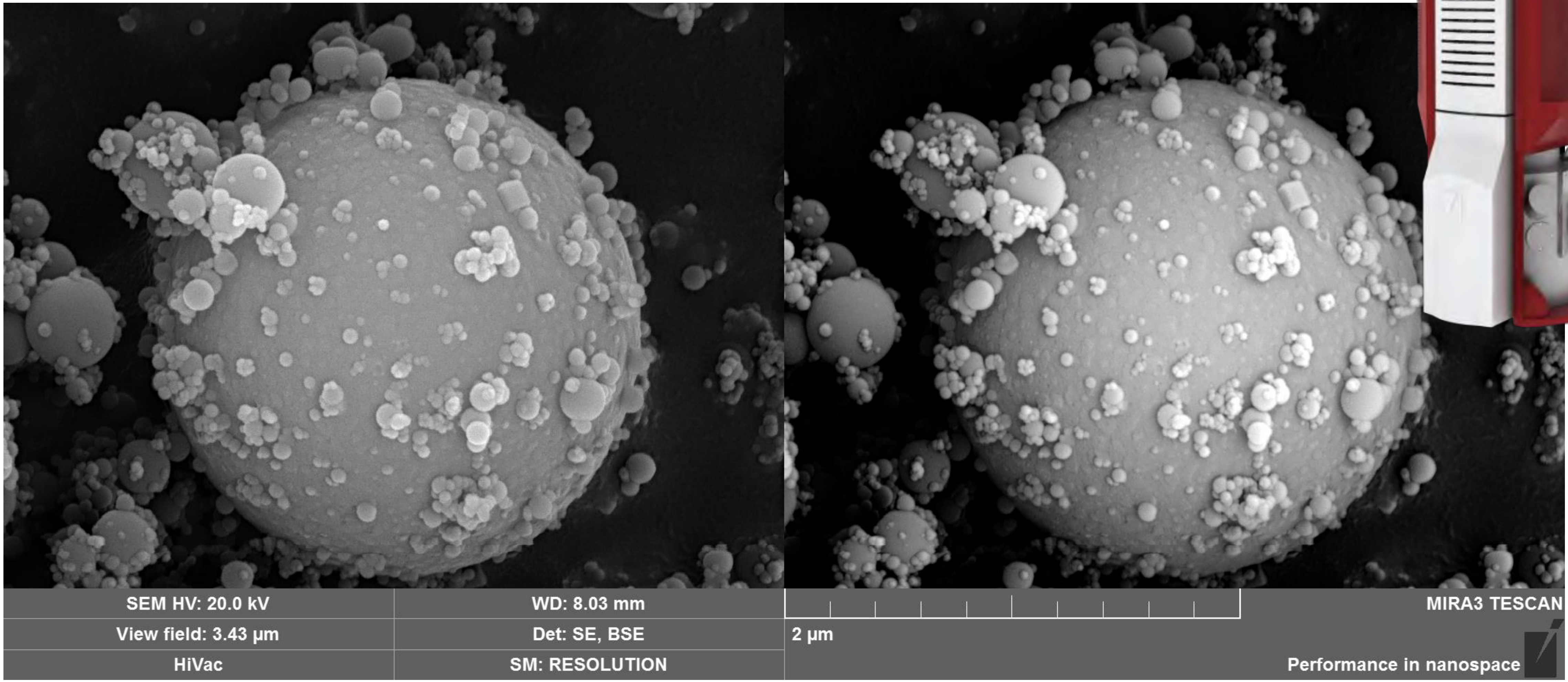




TESCAN with MEX software

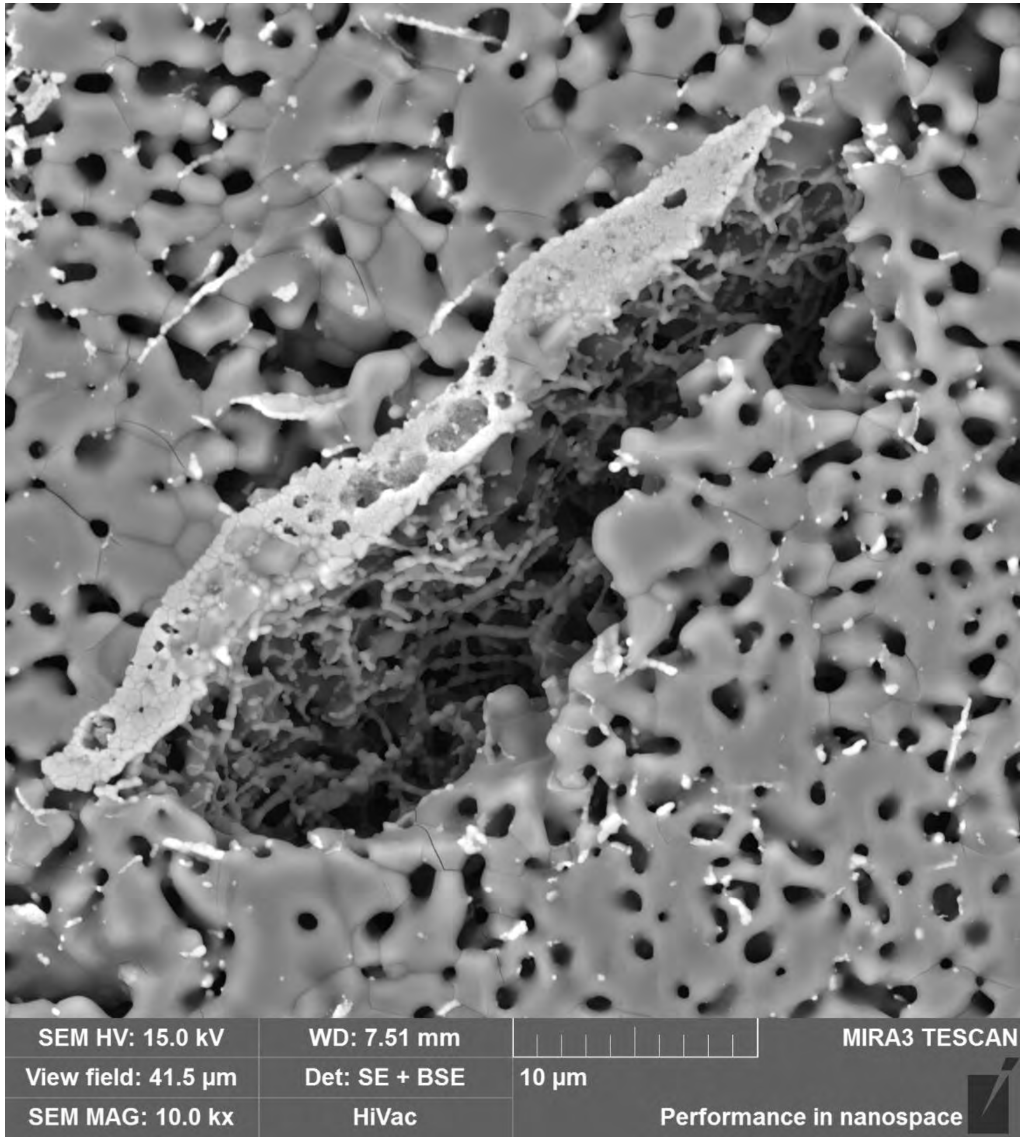
MIRA – Application Examples

- **Silica powder**

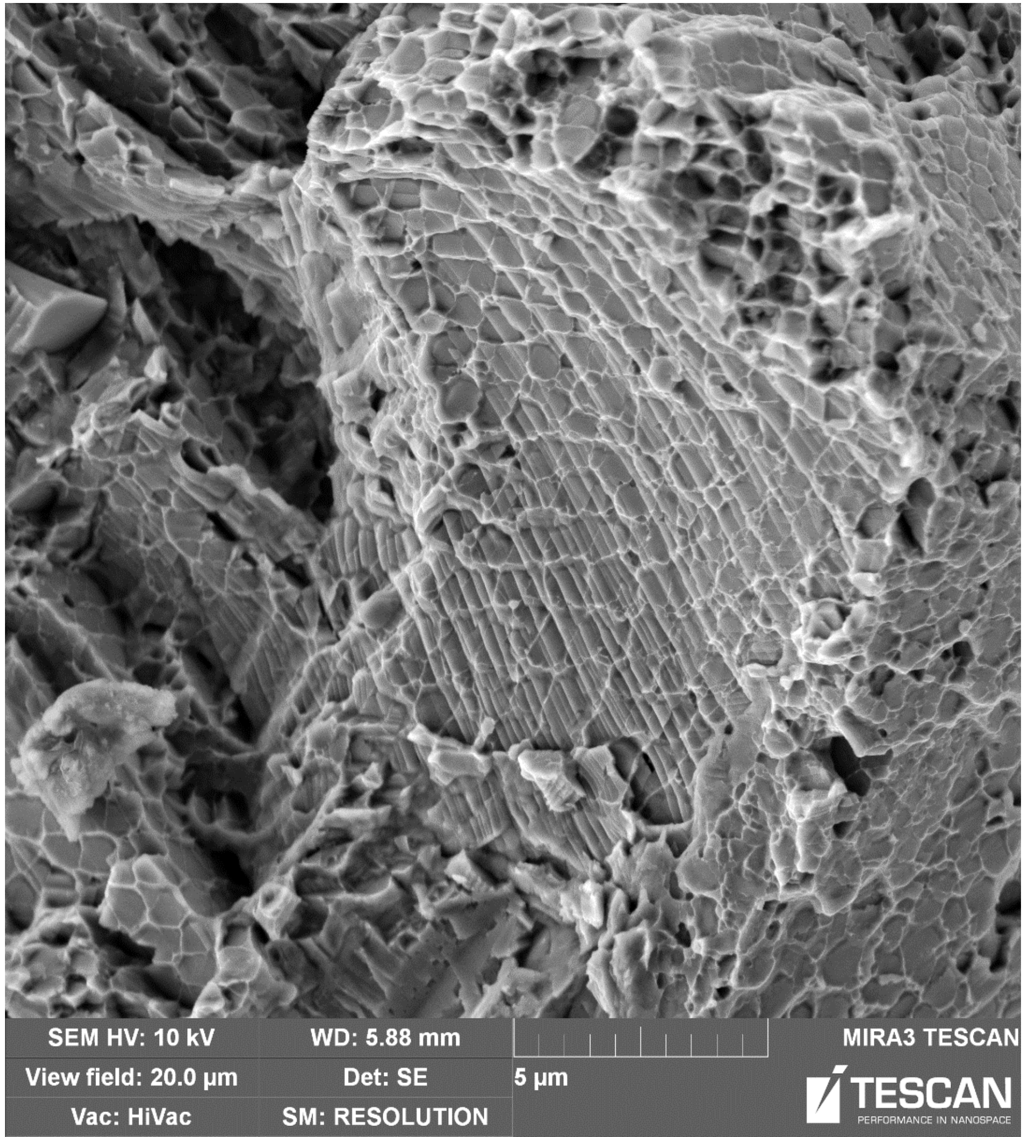


MIRA – Application Examples

- Ceramic sample – ZrO2 wires

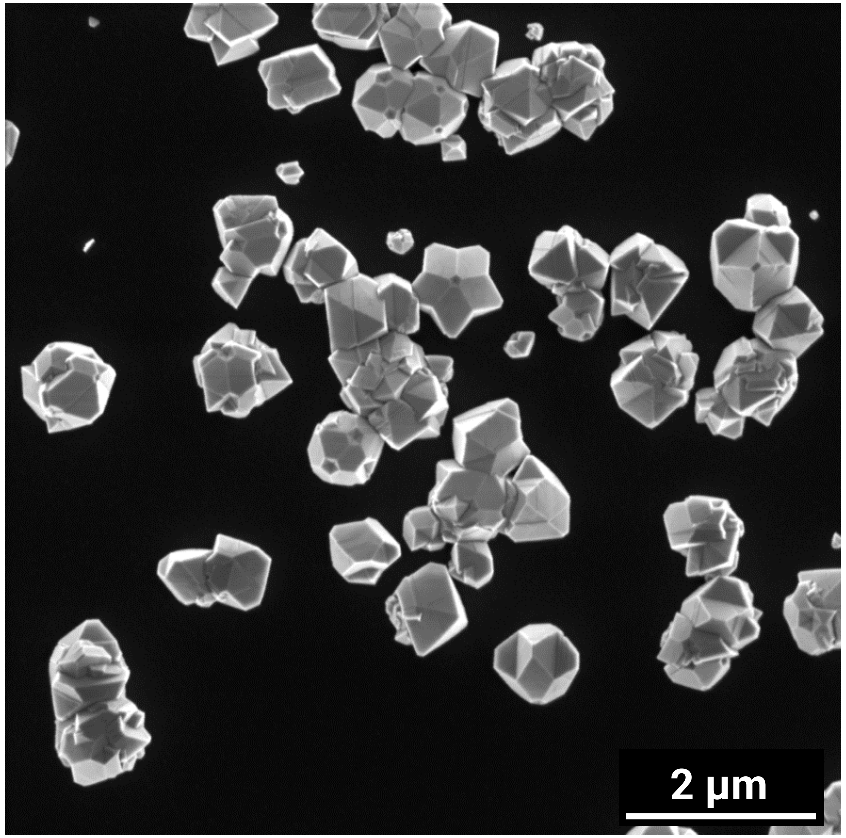


- Inconel – Fracture surface

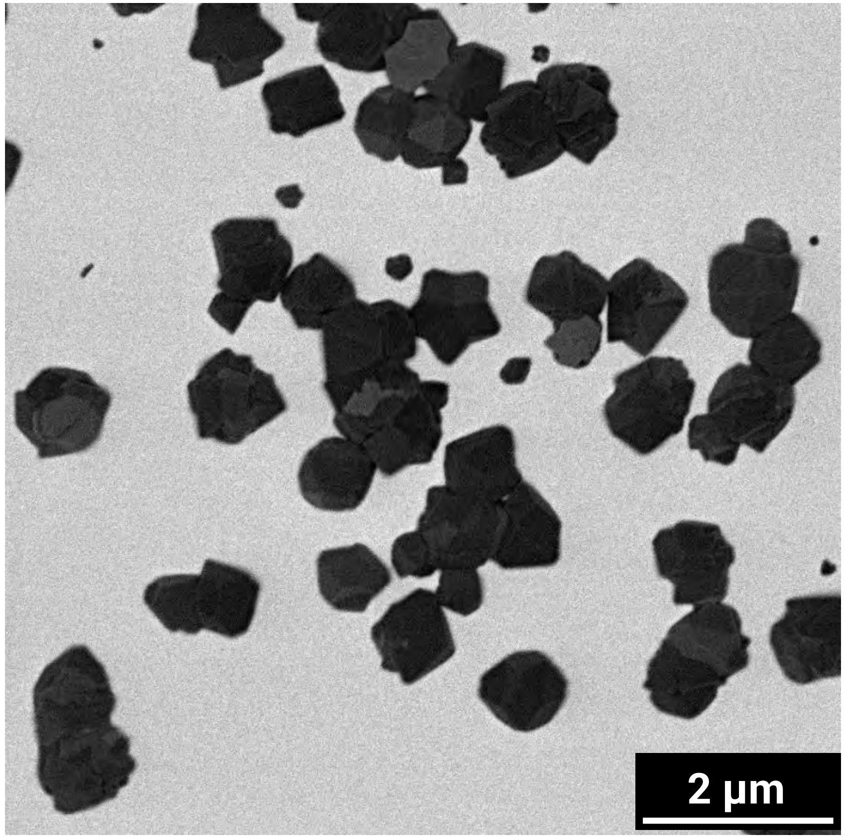


MAIA – Application Examples

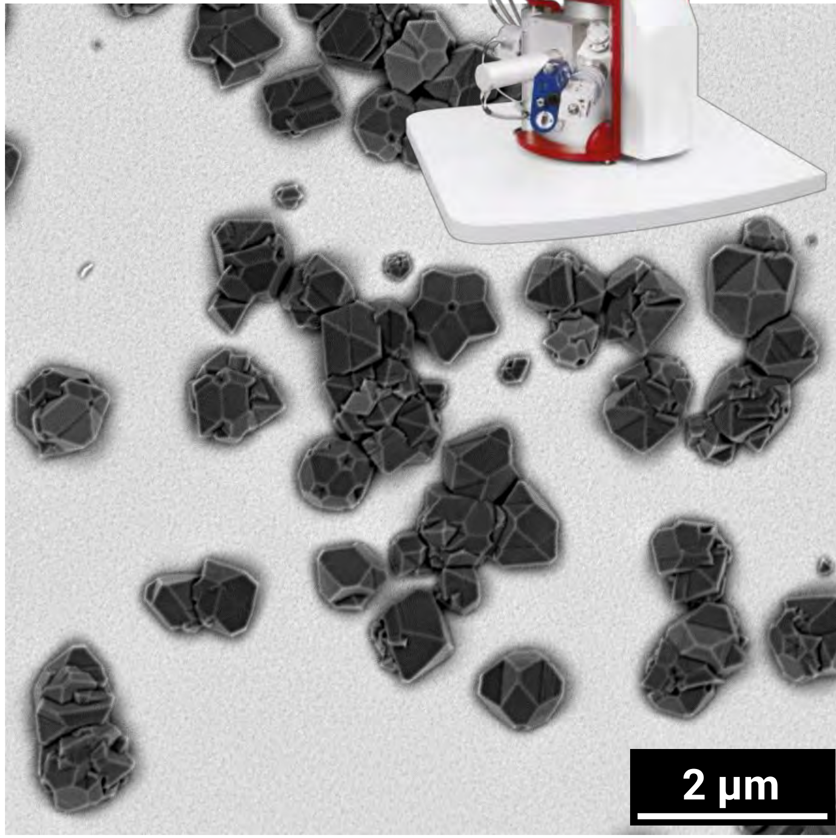
- **Silicon substrate with nanocrystalline diamonds with Si vacancies**



In-Beam SE detector for high topography contrast (2 kV).



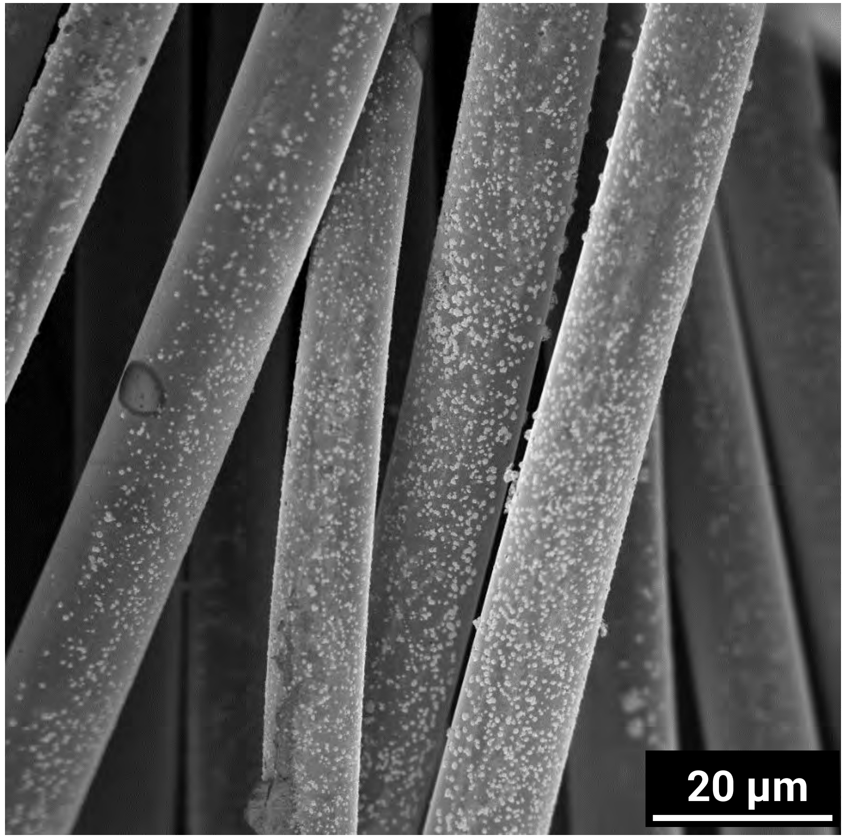
In-Beam BSE detector for pure material contrast (2 kV).



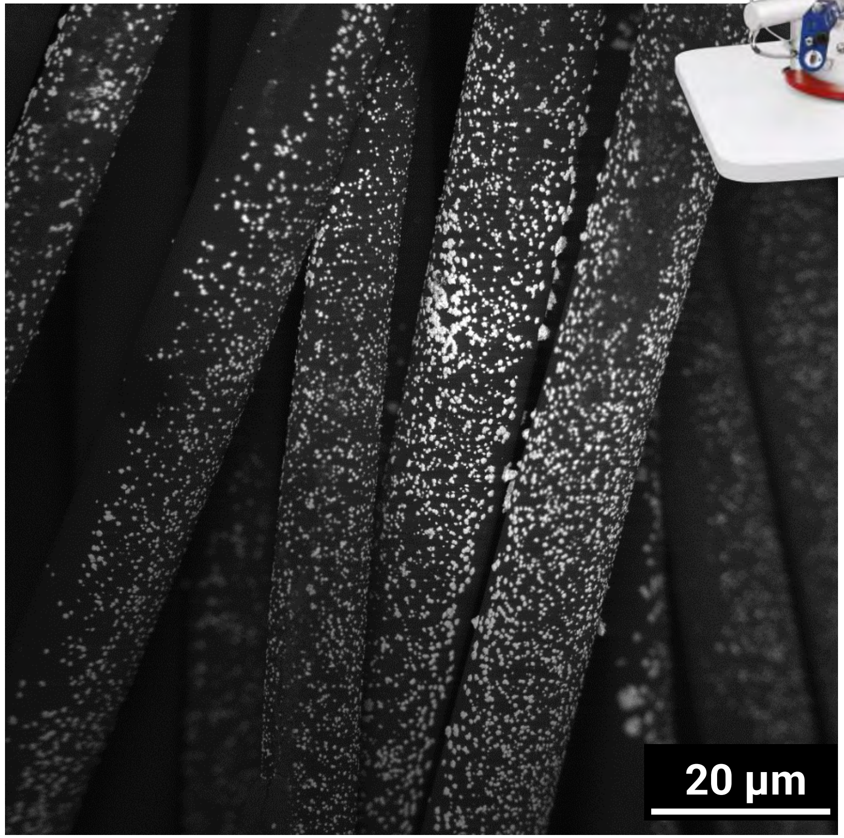
Mid-Angle BSE detector for both material and topographical contrast (2 kV).

MAIA – Application Examples

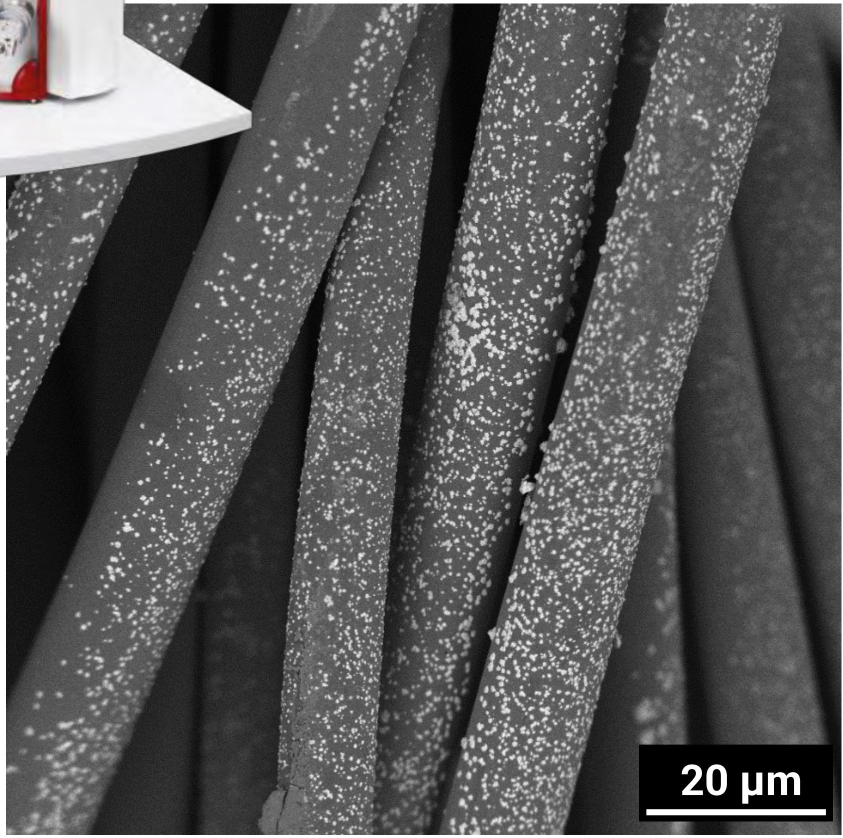
- **Carbon fibers with silver nanoparticles**



In-Beam SE detector for high topography contrast (1 kV).



In-Beam BSE detector for pure material contrast (1 kV).



Mid-Angle BSE detector for both material and topographical contrast (1 kV).

S8000G
Excellent FIB-SEM

BrightBeam™ SEM column

In-Beam detector system

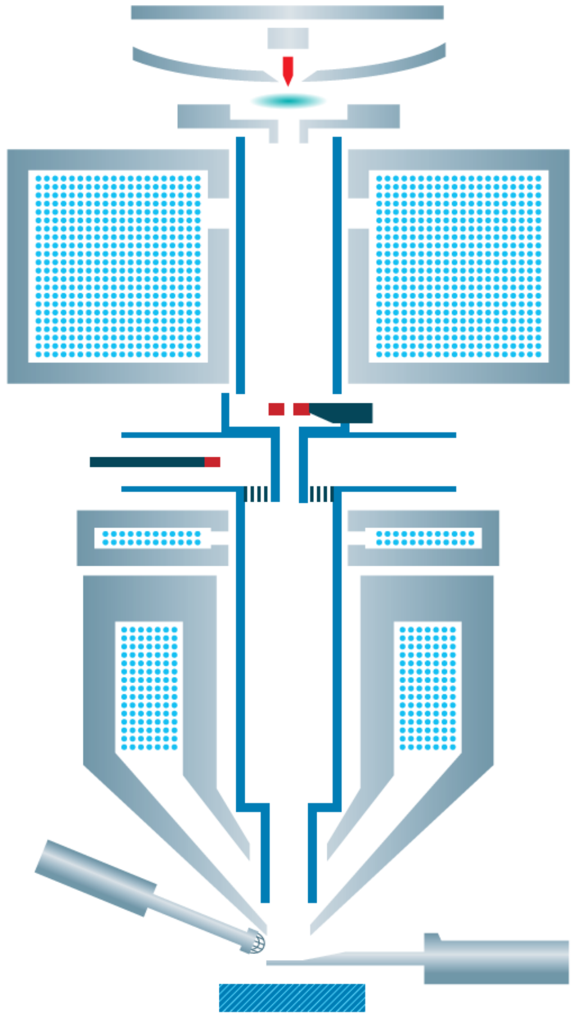
Orage™ FIB column

New HW

TESCAN Essence™ SW

New design

S8000G – BrightBeam™ SEM Column



- **Ultra High Reslution Field-Free SEM**
  - Excellent imaging at low energies
- **High Performance Field-emission Electron gun**
  - 10x faster changes of acceleration voltage
  - Probe current up to 400 nA
- **EquiPower™ Technology**
  - Constant power dissipation for high stability
- **In-Flight Beam Tracing ™**
  - Accurate real-time computation of optical parameters
- **Wide Field Optics**
  - Variety of imaging modes
  - Large field of view imaging

S8000G – High Resolution Imaging at Low kV

Combined electrostatic-magnetic lens enables **field-free ultra-high resolution imaging**

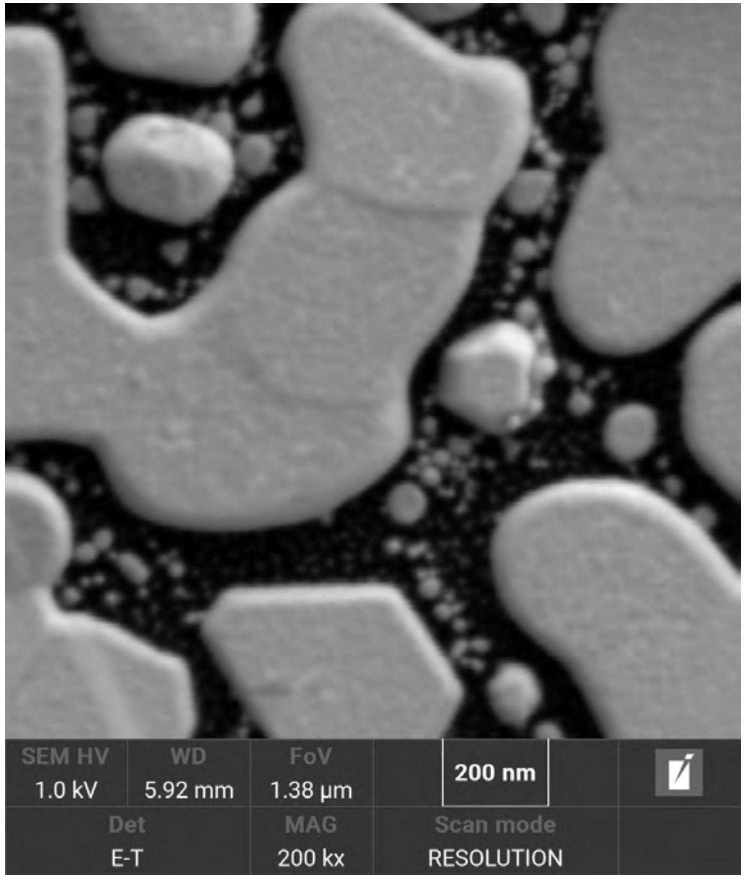
Resolution specs:

15 kV	0.9 nm (field-free)
1 kV	1.7 nm (field-free)
1 kV	1.4 nm (BDM)

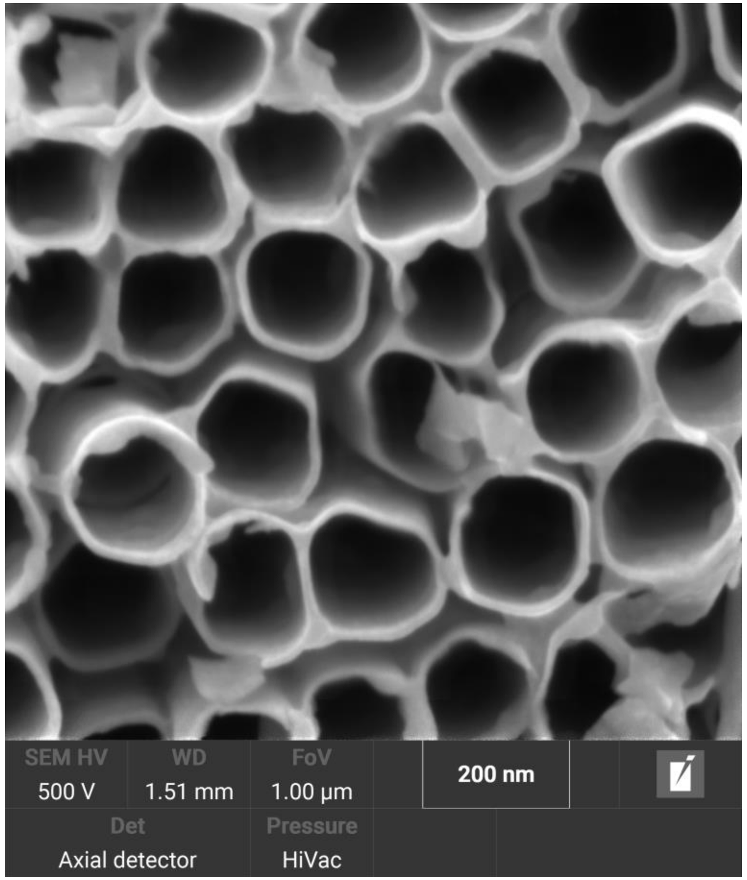
Electron Beam Energy:

50 eV to 30 keV

down to 0 eV with manual BDM



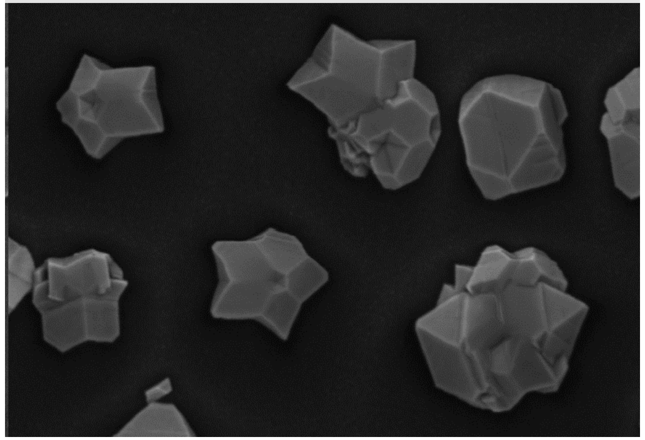
Au on C, 1kV, field-free



TiO_2 nanotubes, 500 V field-free

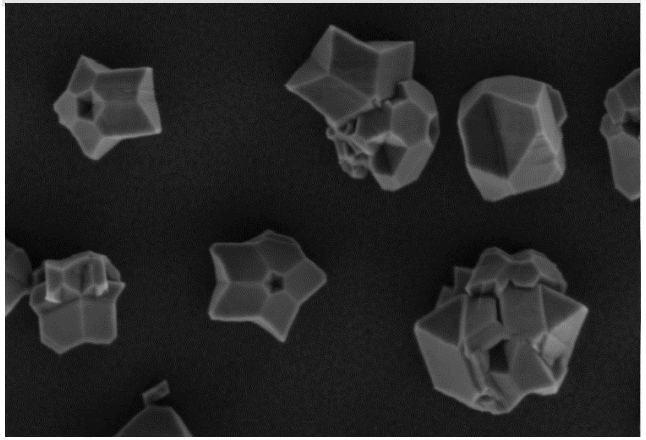
S8000G – Detection system

Axial Detector

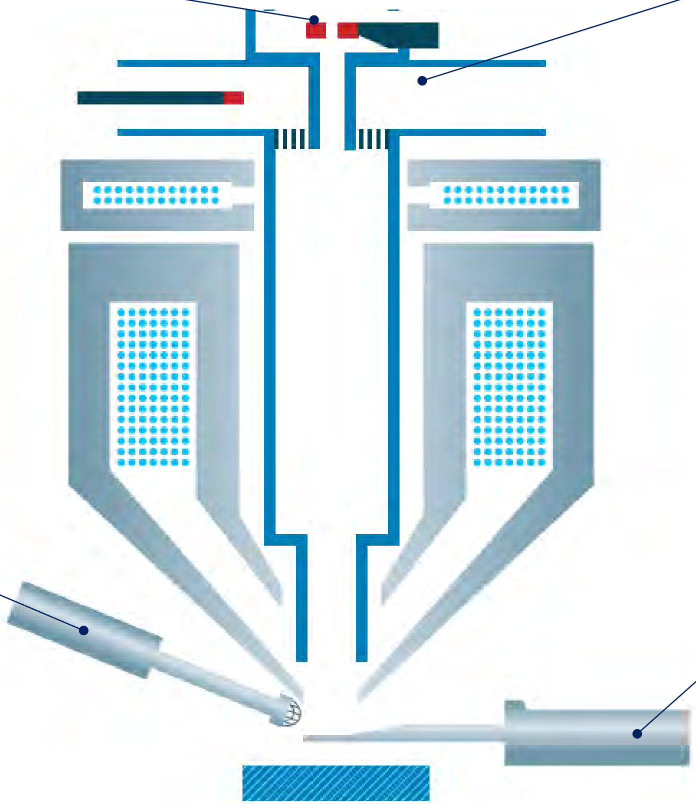


SE (BDM), SE

E-T detector

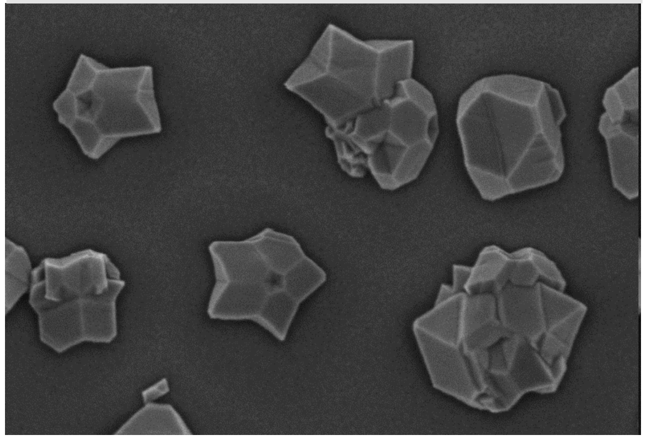


Topographical BSE SE (booster off)



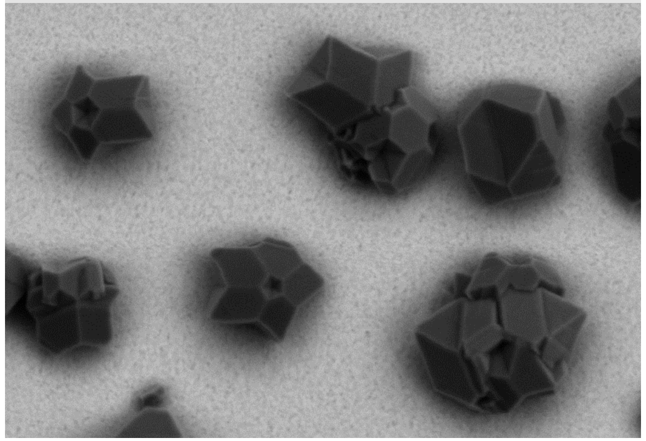
4 detectors and 9 signals to explore!

Multidetector



Filter Grid - SE x BSE

BSE-LE detector

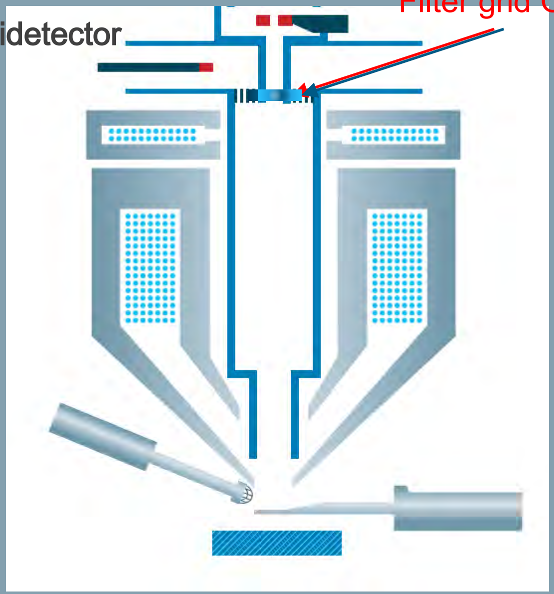


Wide-angle BSE

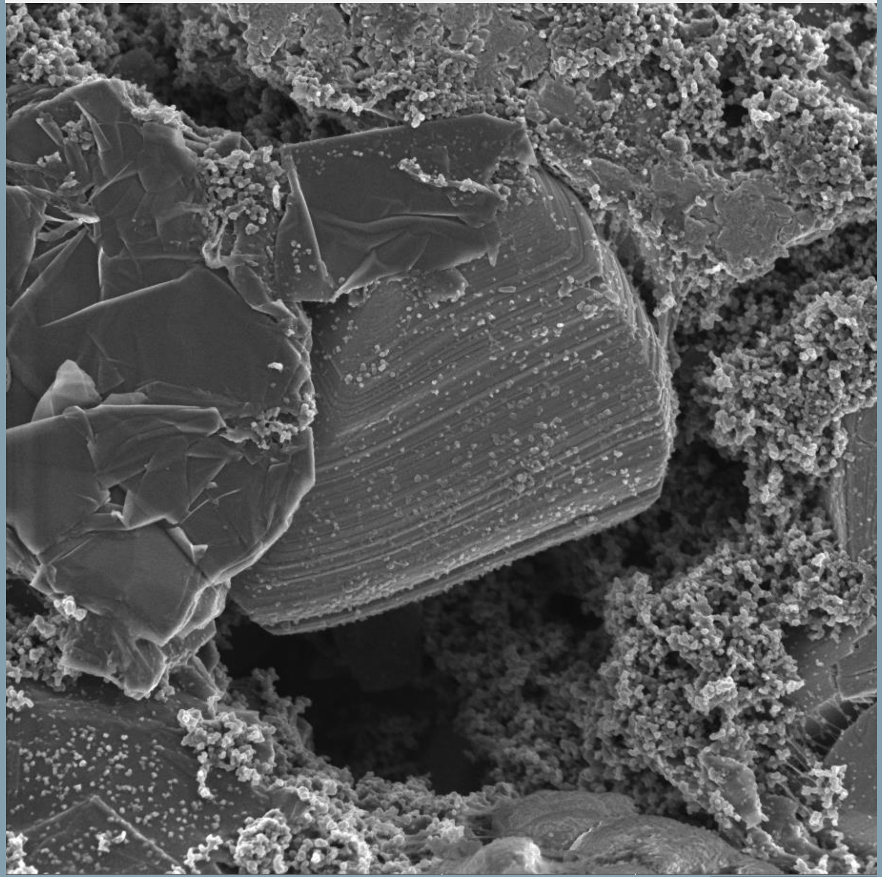
Detection system

SE and BSE SELECTION BY FILTERING WITH A MULTIDETECTOR

Li battery cathode

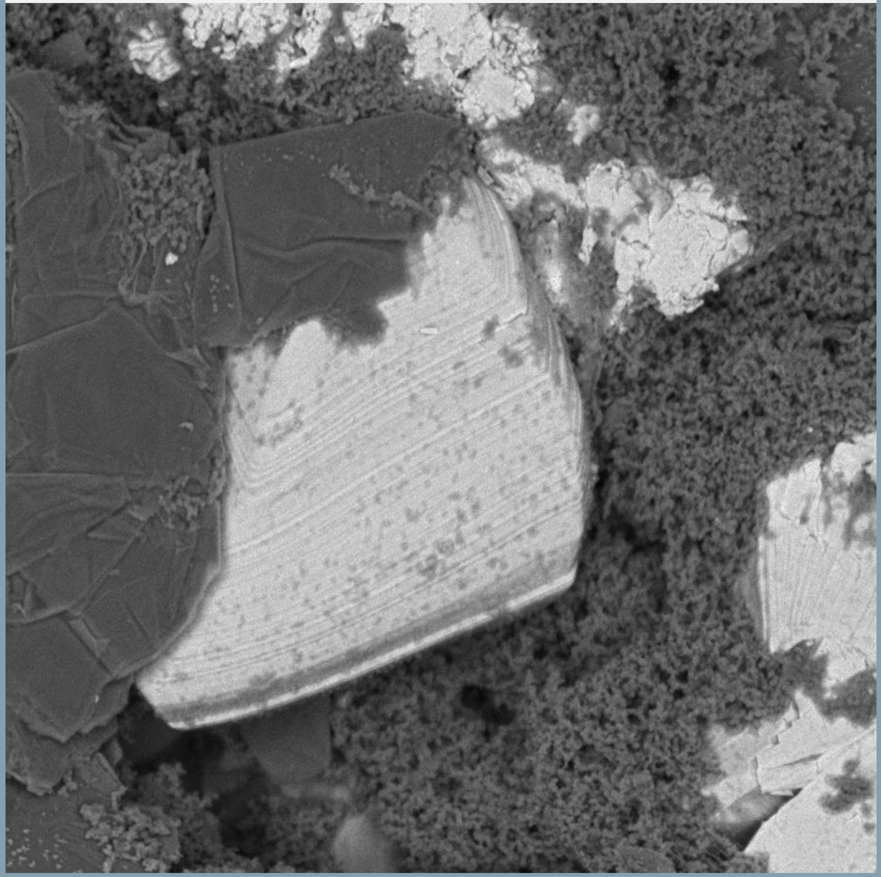


Grid OFF = SE signal



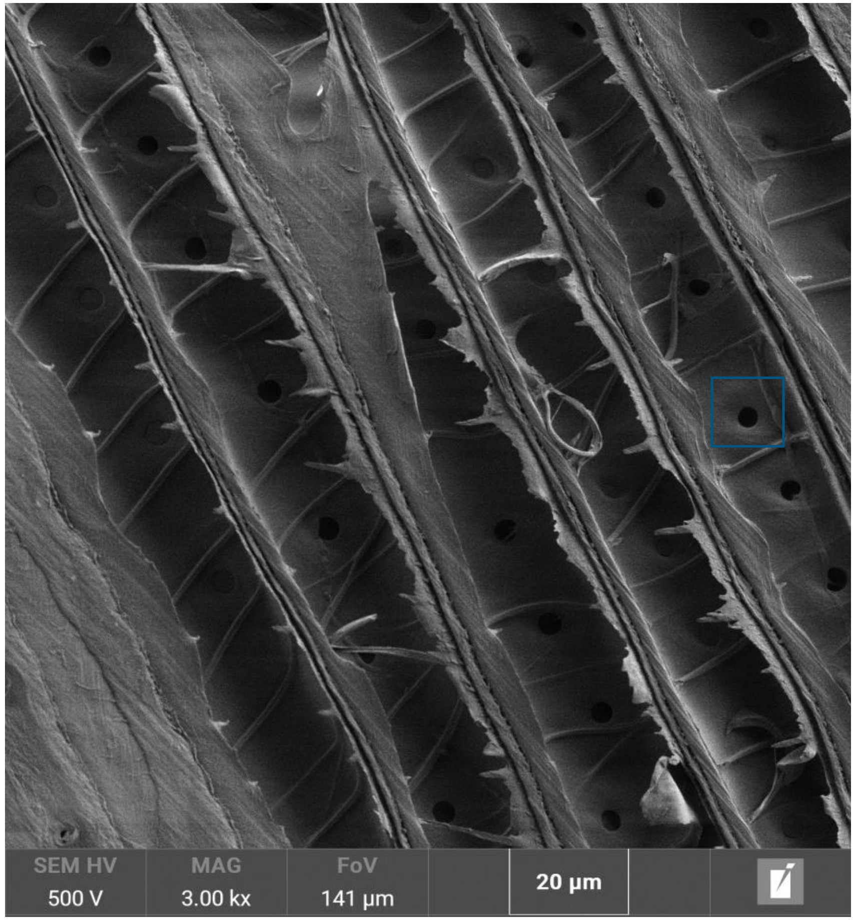
Resolution, topography, typical edge contrast

Grid ON = BSE signal

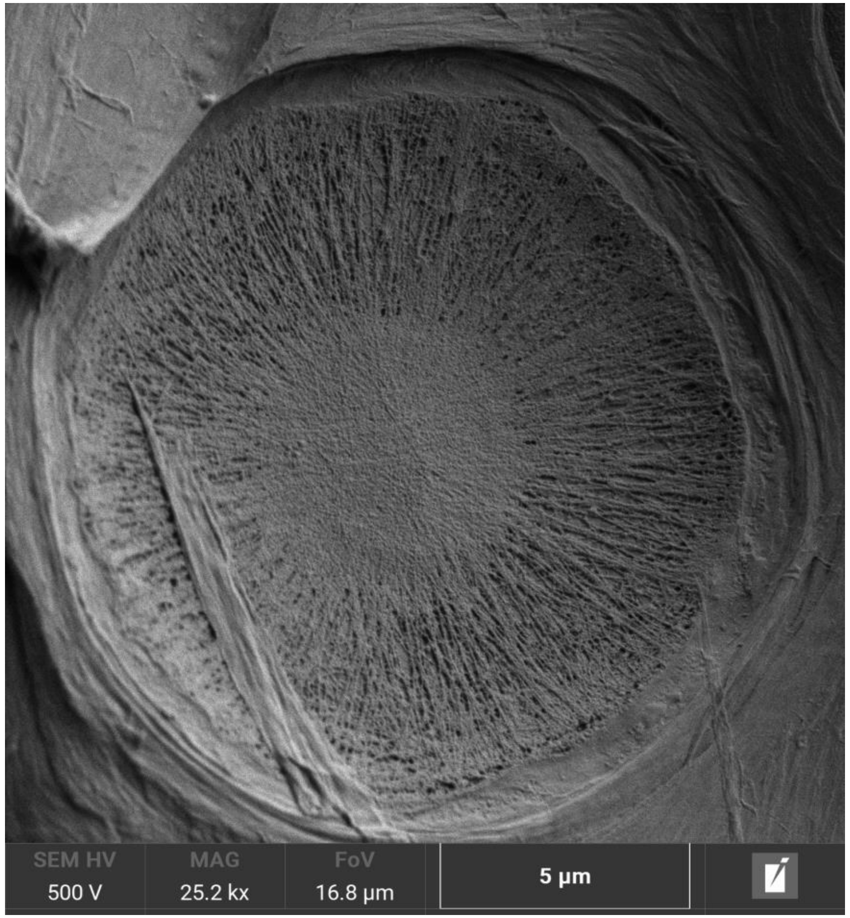


Material contrast

S8000G – Wood - Taxus

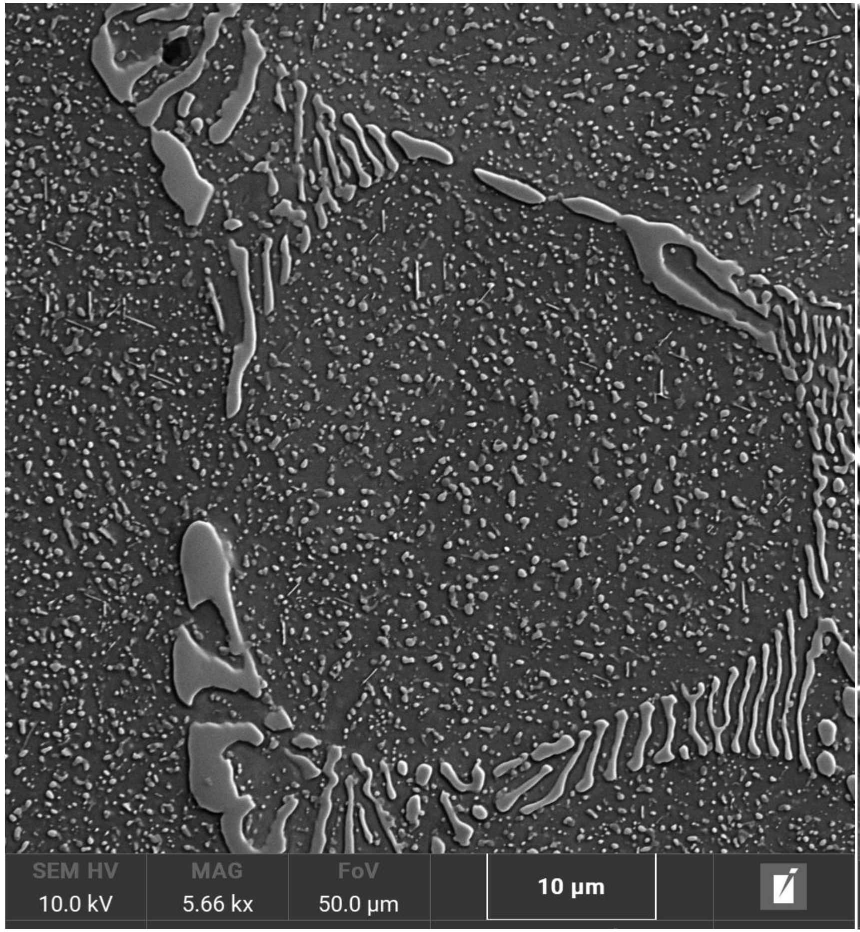


500V E-T Detector

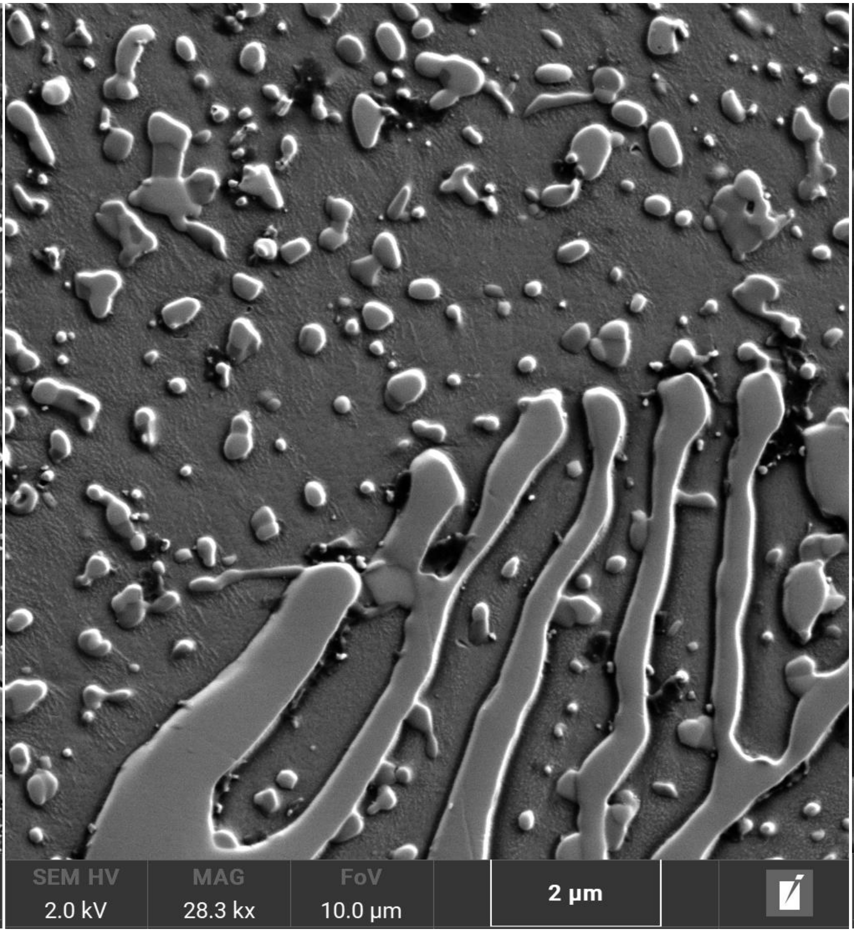


500V E-T Detector

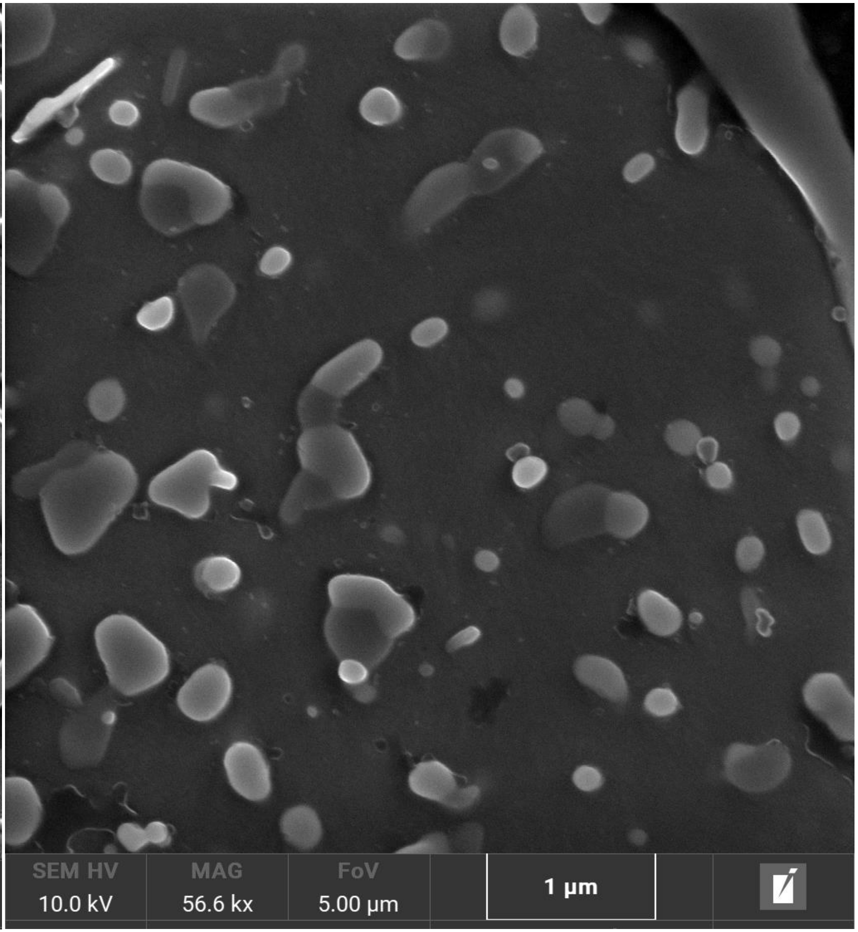
S8000G – High-Speed Steel – Ferromagnetic sample



10kV E-T Detector

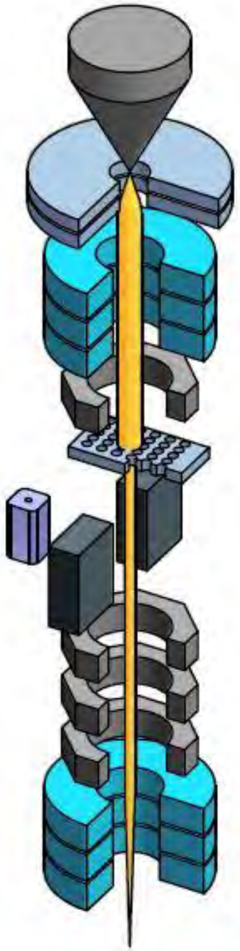


2kV E-T Detector



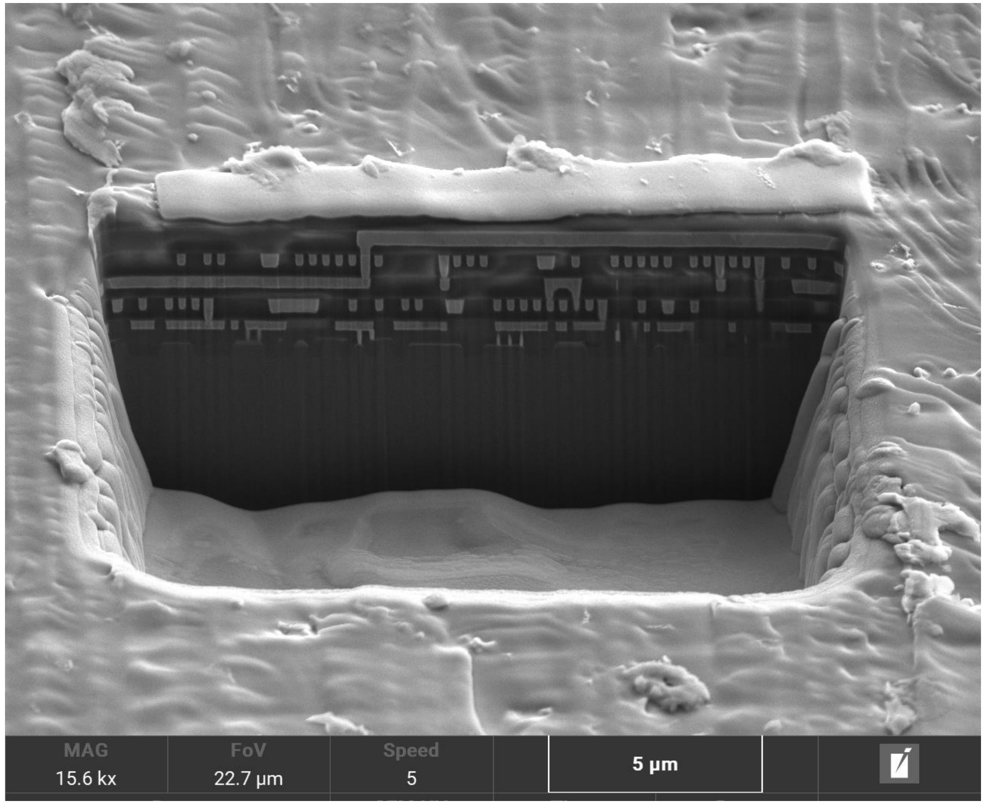
10kV Multi-Detector

S8000G – Orage FIB Column

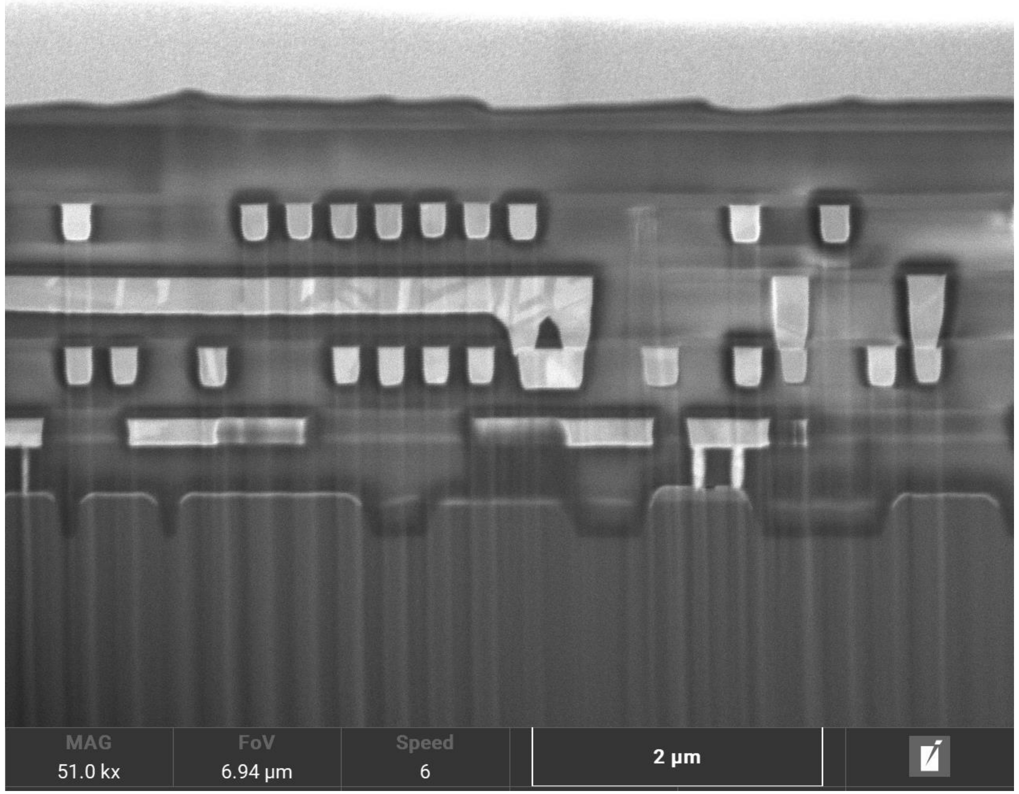


- **Next Generation FIB Column Design**
- **Improved low energy resolution for ultra-fine machining**
- **Beam current up to 100 nA for large volume milling**
- **Smart column alignment**

Integrated Circuit - 15 µm Polished Cross-Section (done in 4 minutes)

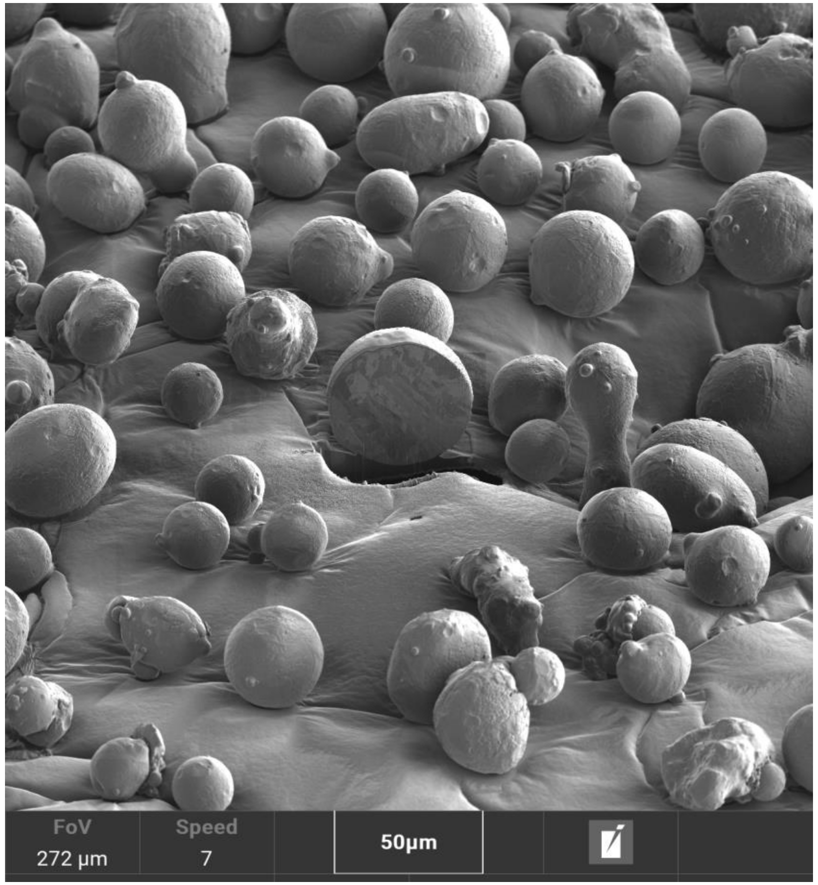


5kV E-T detector

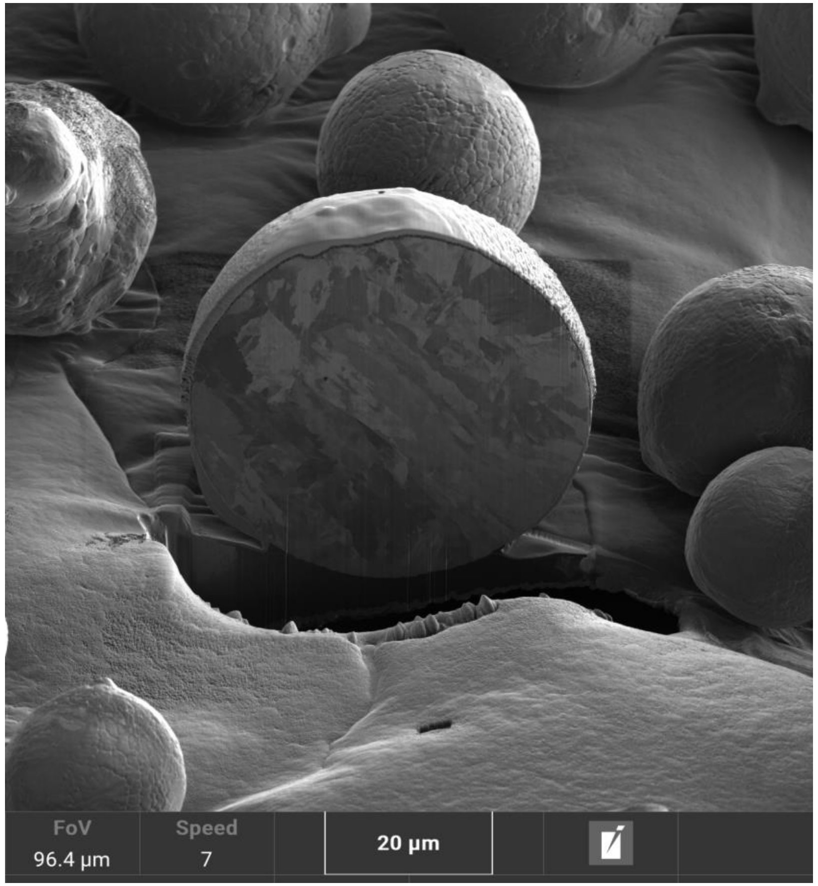


2kV E-T detector

S8000G – Iron Powder – High Speed Crossection



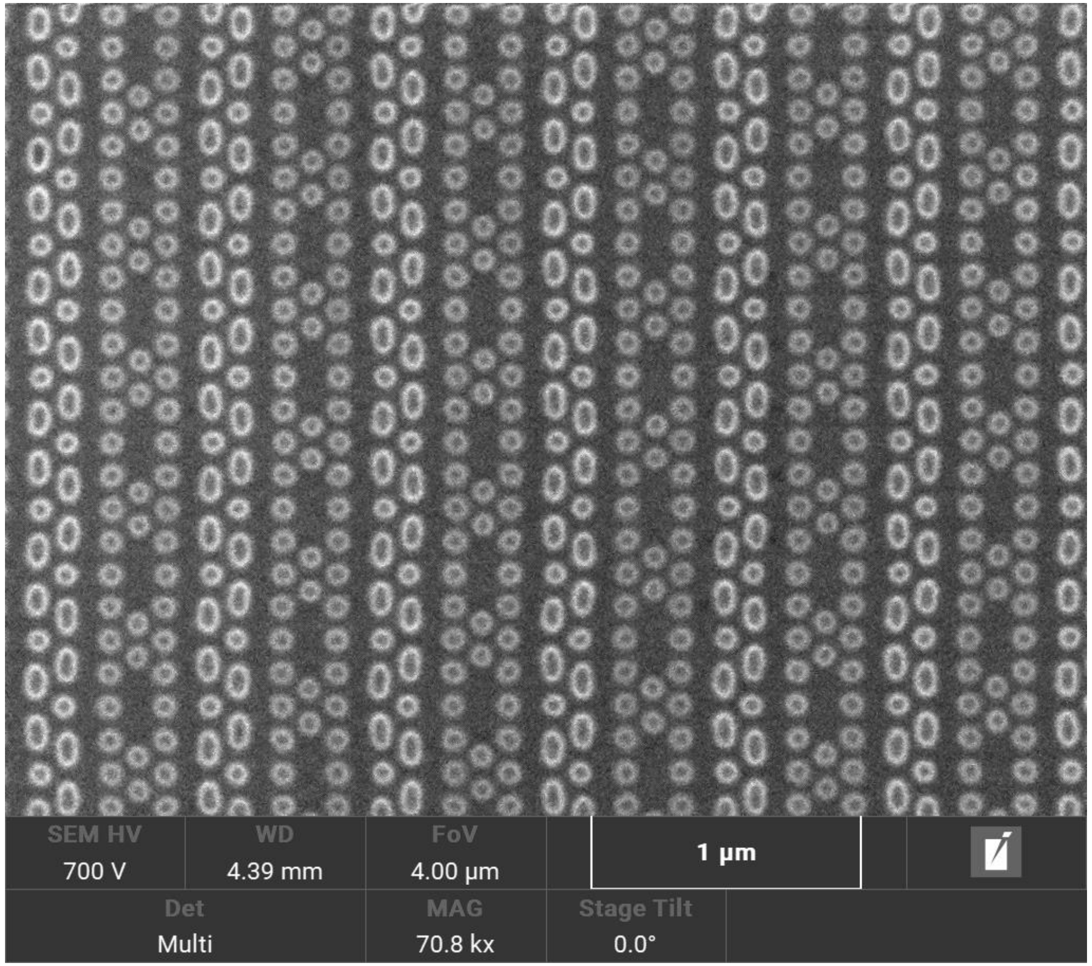
30kV FIB Image E-T detector



30kV FIB Image E-T detector

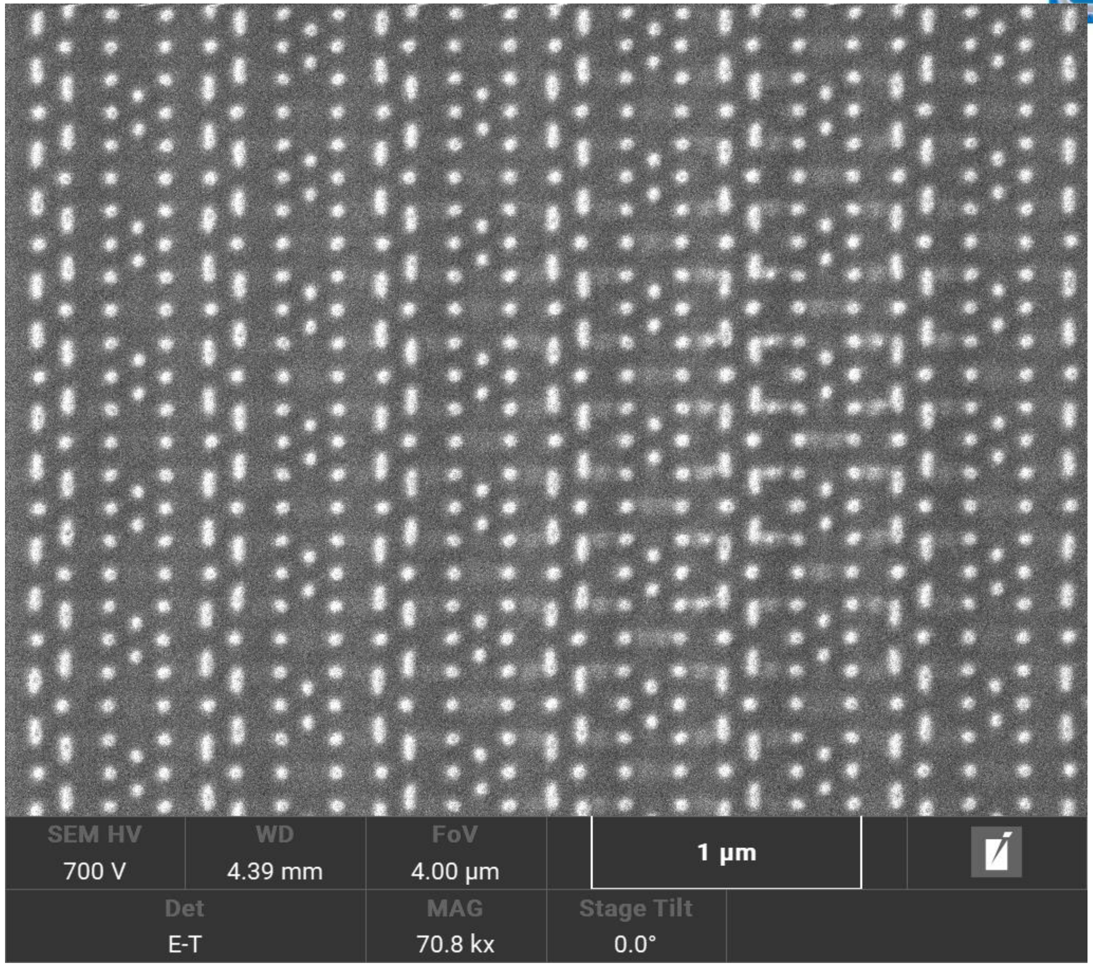
S8000G – Inspection after delayering: Imaging at 700 V

Intel® Pentium® Processor G4400
(3M Cache, 3.30 GHz)



700V Multi detector

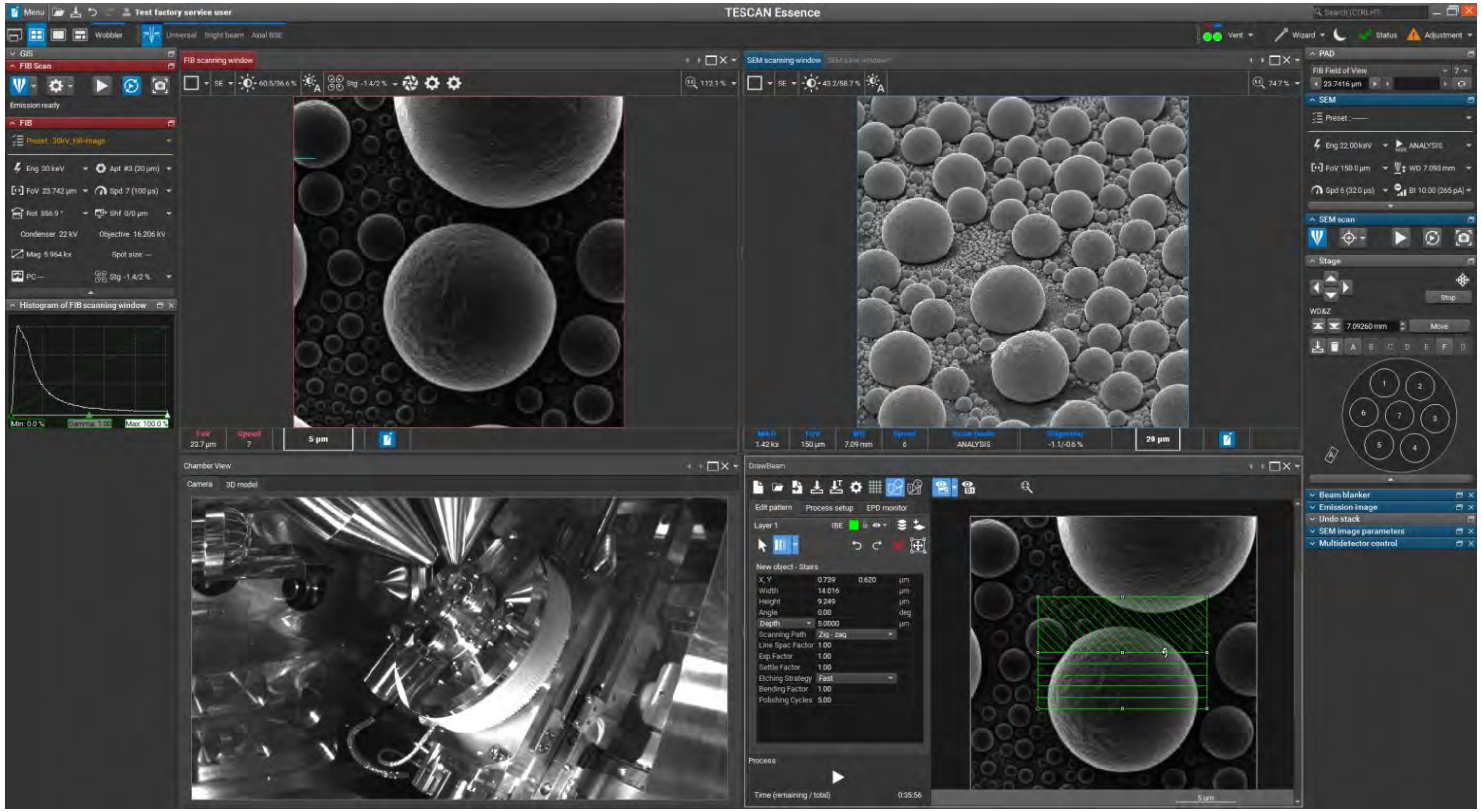
Voltage contrast



700V E-T detector

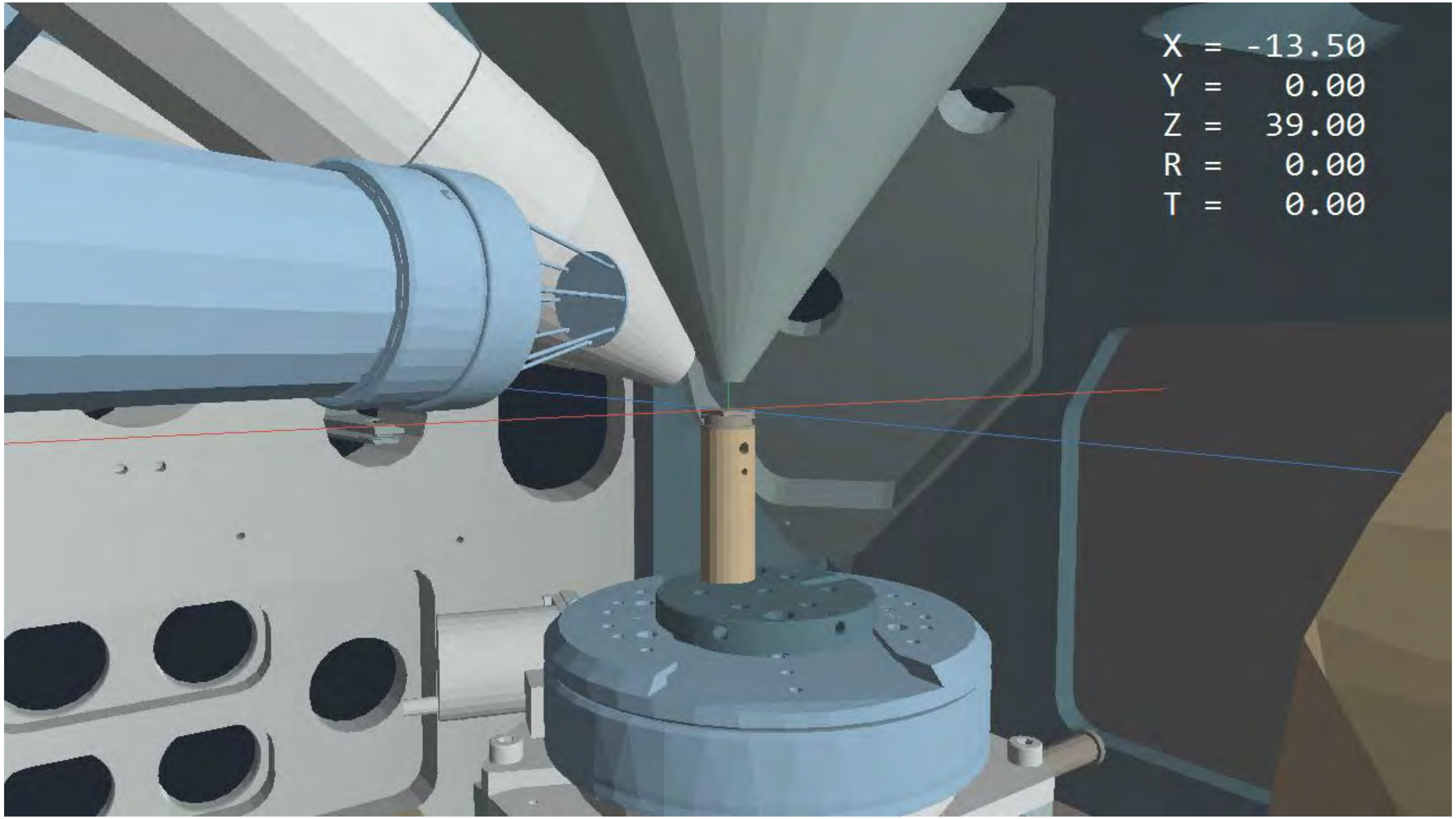
Topography: residual of the previous layer

TESCAN Essence^{TM} software



- Simplified GUI
- Application specific layout
- Layout manager for image windows
- Workflow-oriented wizards
- DrawBeam for live & static window
- Chamber view
- 3D collision model
- Quick search box
- SEM/FIB undo-redo
- Report template editor
- Easy-to-learn for all users

TESCAN Essence™ software



DUAL BEAM SYSTEMS

Dual Beam Systems – Ga^+, Xe^+

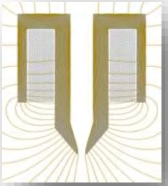
COBRA FIB column

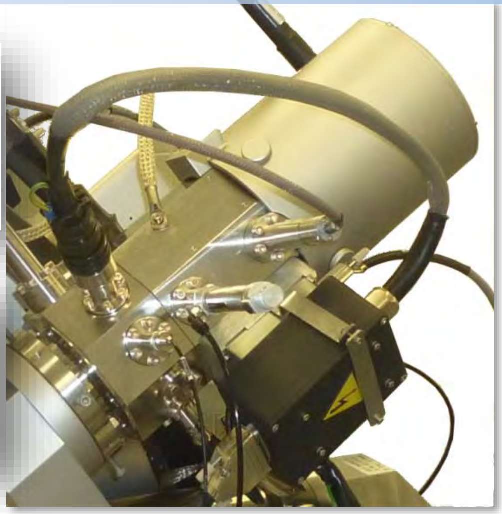
Analytical Performance

1.2 nm at 15 kV

High Resolution

0.7 nm at 15 kV





- **Ga^+ ions**
- **High resolution: 2.5 nm @ 30 kV**
- **In-Flight Beam Tracing**
- **Probe current control**
- **Spot size computation**

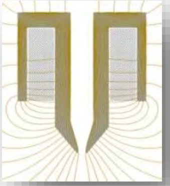
iFIB plasma column

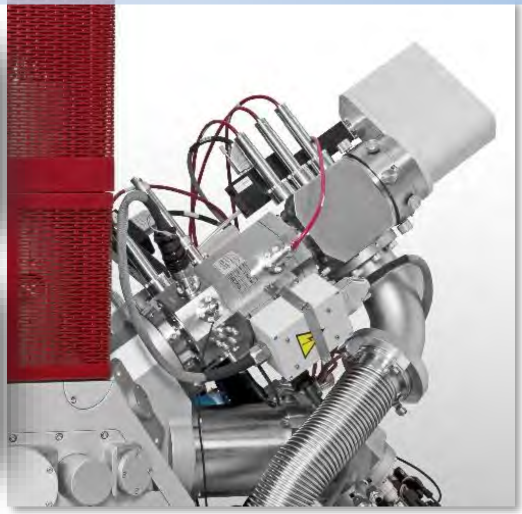
Analytical Performance

1.2 nm at 15 kV

High Resolution

0.7 nm at 15 kV

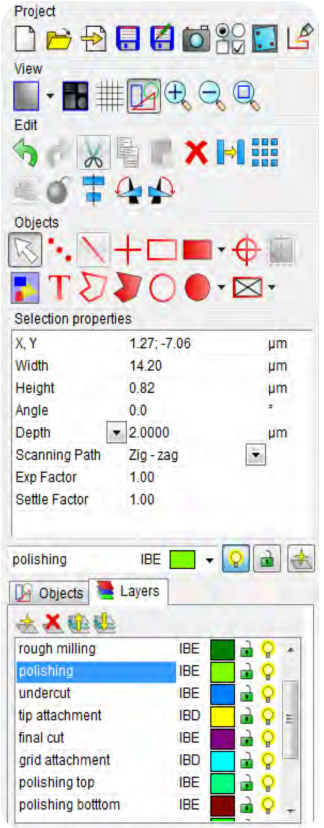


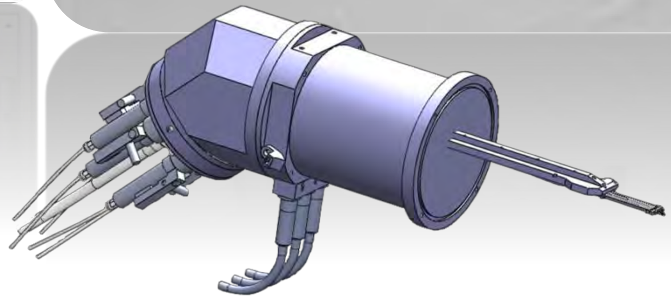


- **Xe^+ ions**
- **High resolution: 15 nm @ 30 kV**
- **Continuously adjustable current up to 2 uA**
- **Probe current control**
- **Spot size computation**

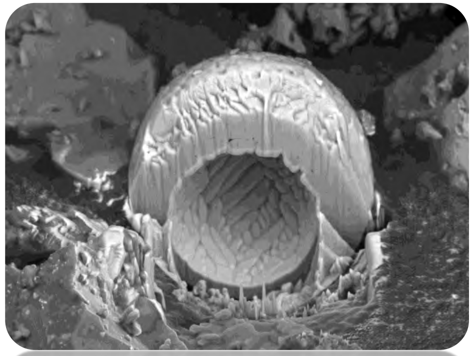
TESCAN PERFORMANCE IN NANOSPACE

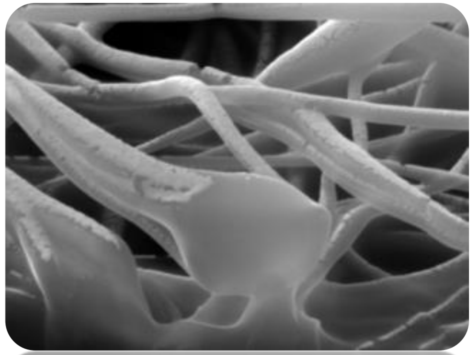
Ga^+, Xe^+



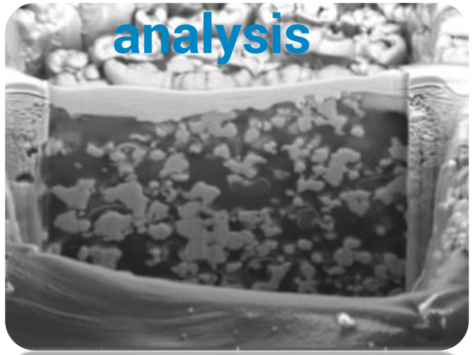


Cross-sectioning

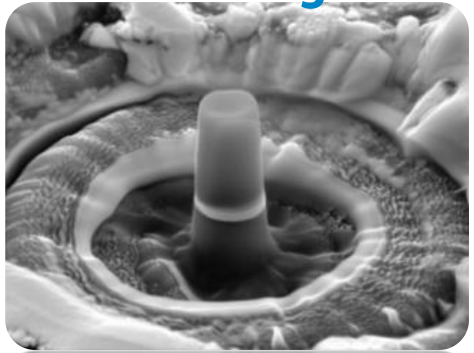




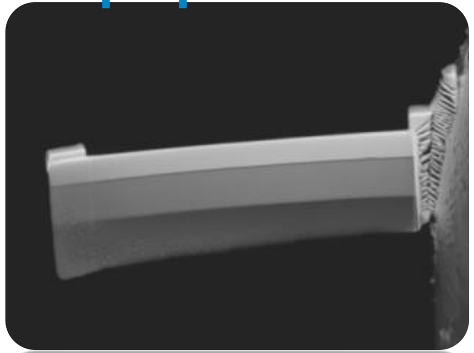
Volume analysis



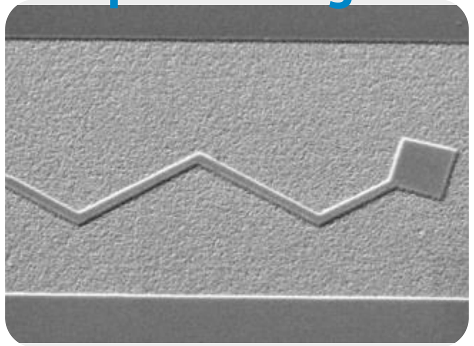
Pillars for mechanical testing



TEM lamella preparation

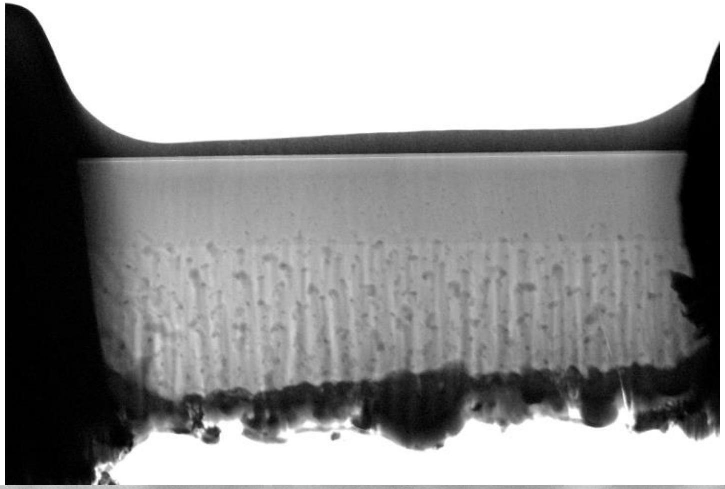


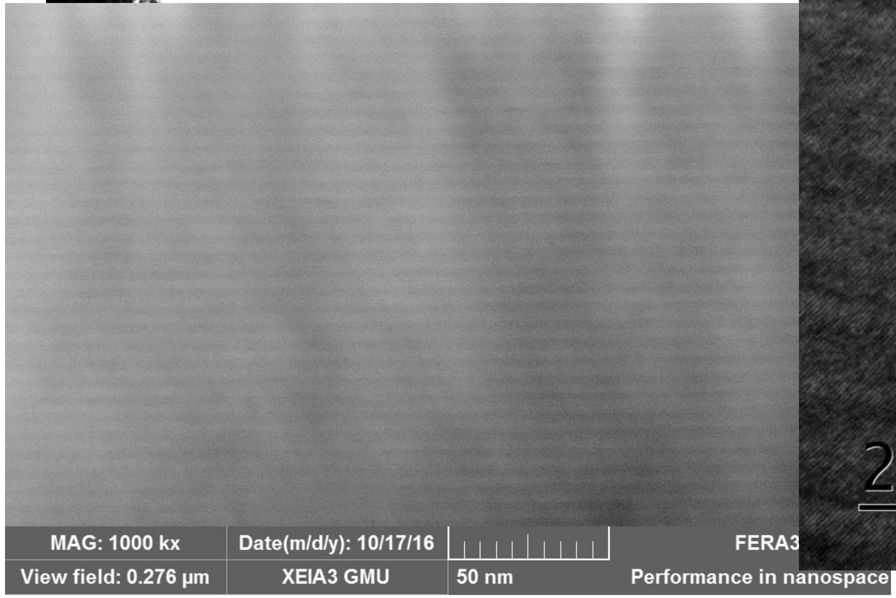
Ion Beam patterning

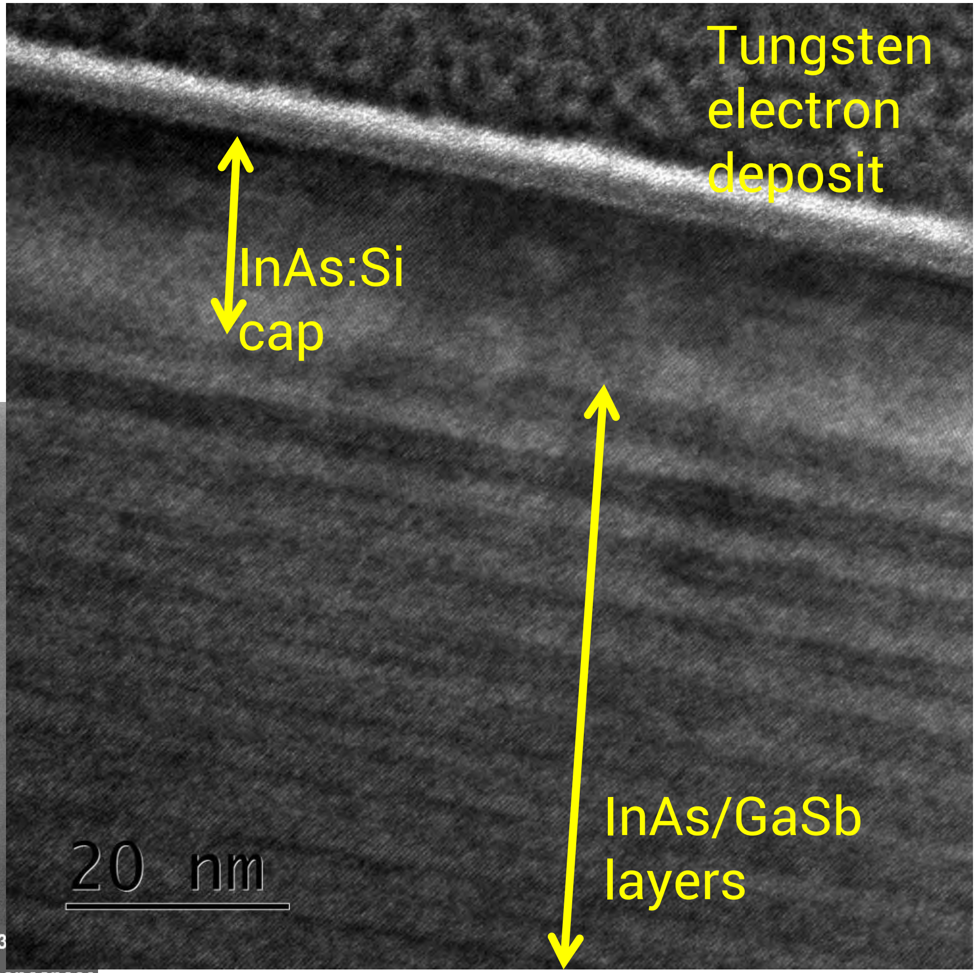


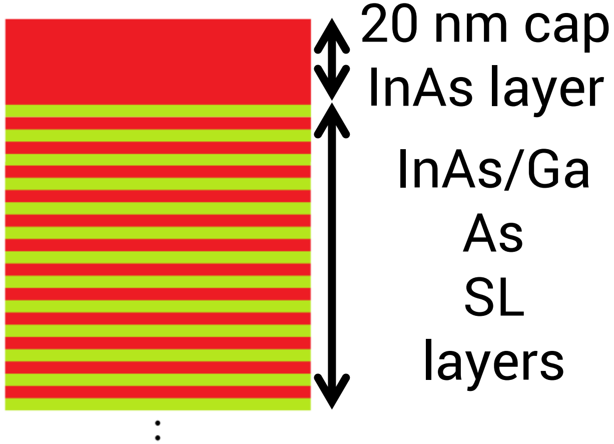
Xe+

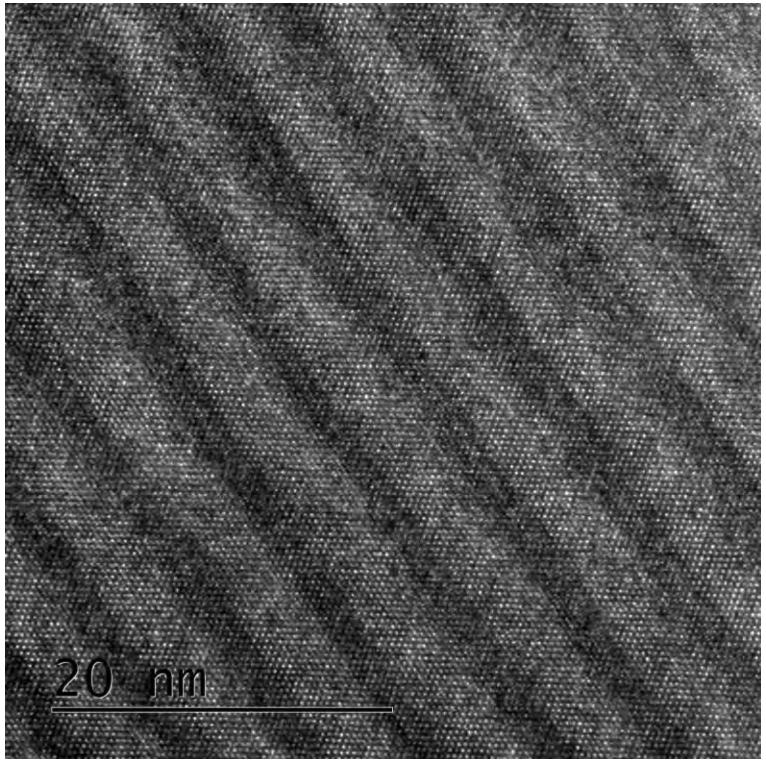
- **II InAs/GaSb superlatice (T2SL) structrure on GaSb substrate**





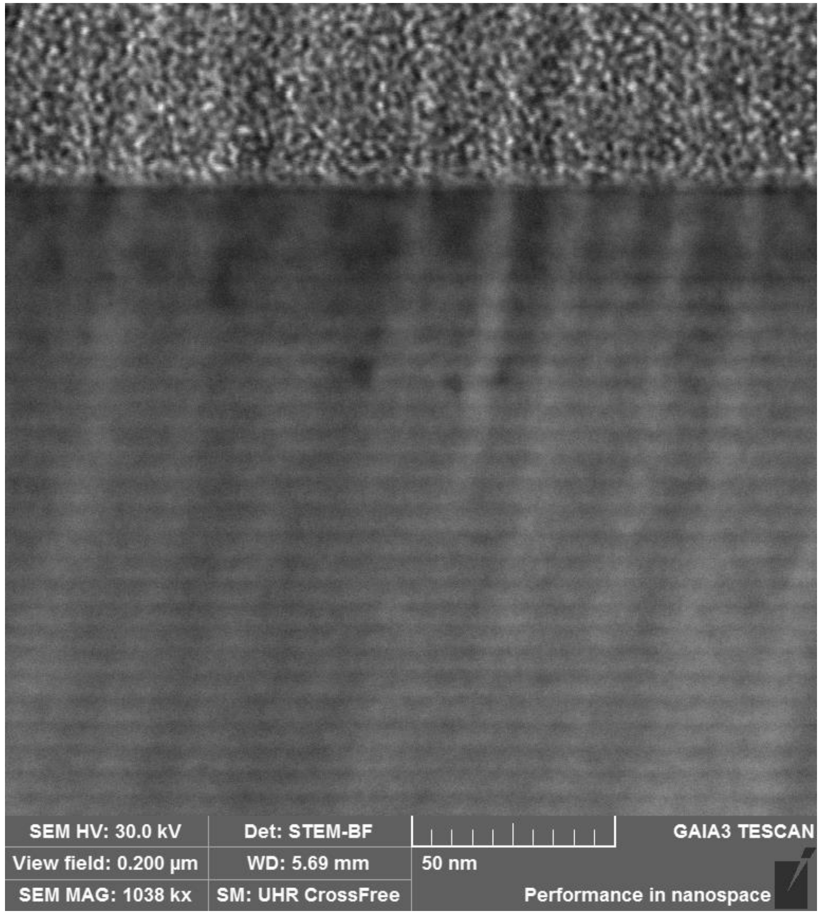




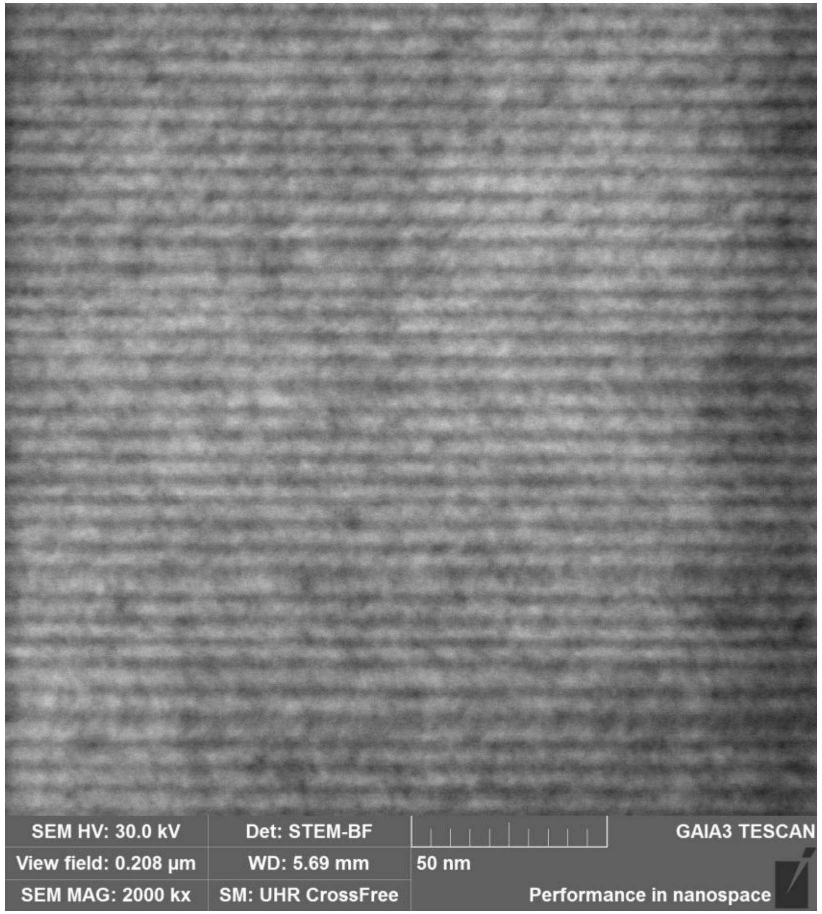


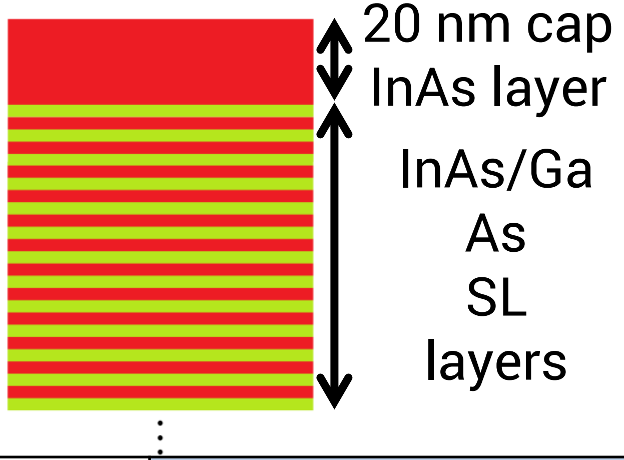
Ga+

- **II InAs/GaSb superlatice (T2SL) structrure on GaSb substrate**



Ga+

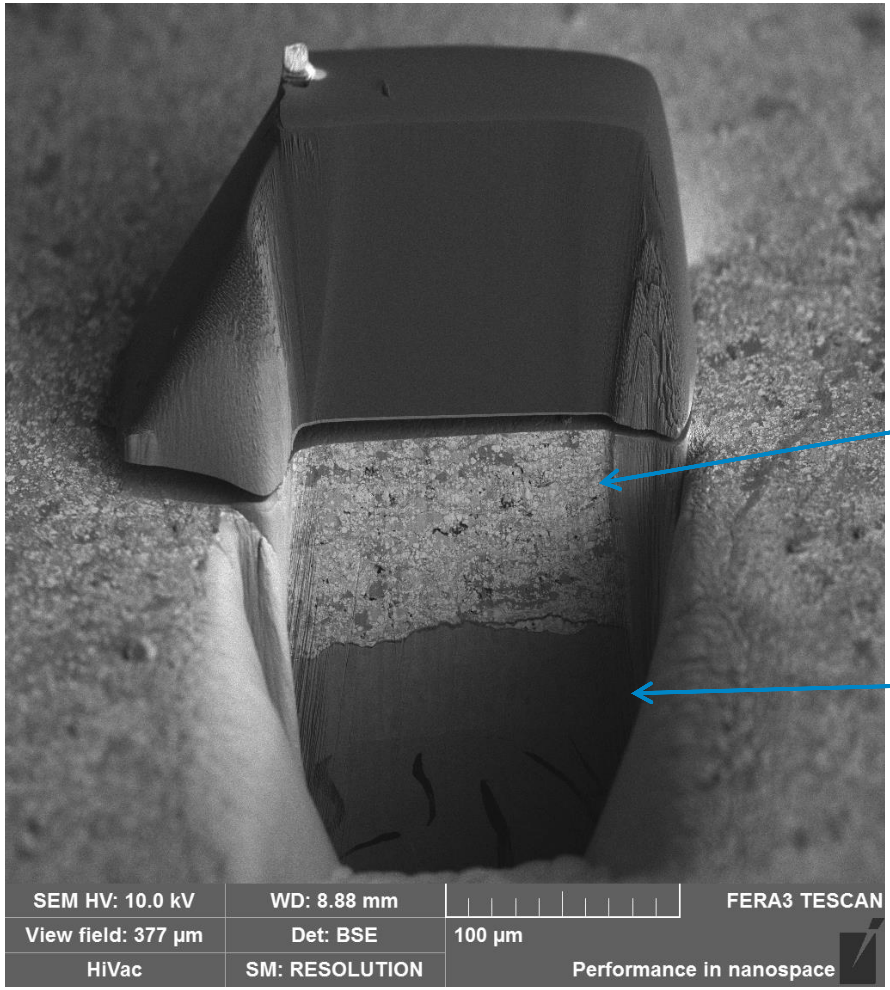




20 nm	n-InAs:Si
x 40	i-GaSb (2.90 nm)
	n-InAs:Si (2.77 nm)
x 60	i-GaSb (2.90 nm)
	i-InAs:Si (2.77 nm)
x 40	p-GaSb:Be (2.90 nm)
	i-InAs (2.77 nm)
1000 nm	p-GaSb
500 nm	i-GaSb
2 inch GaSb substrate	

Xe^+

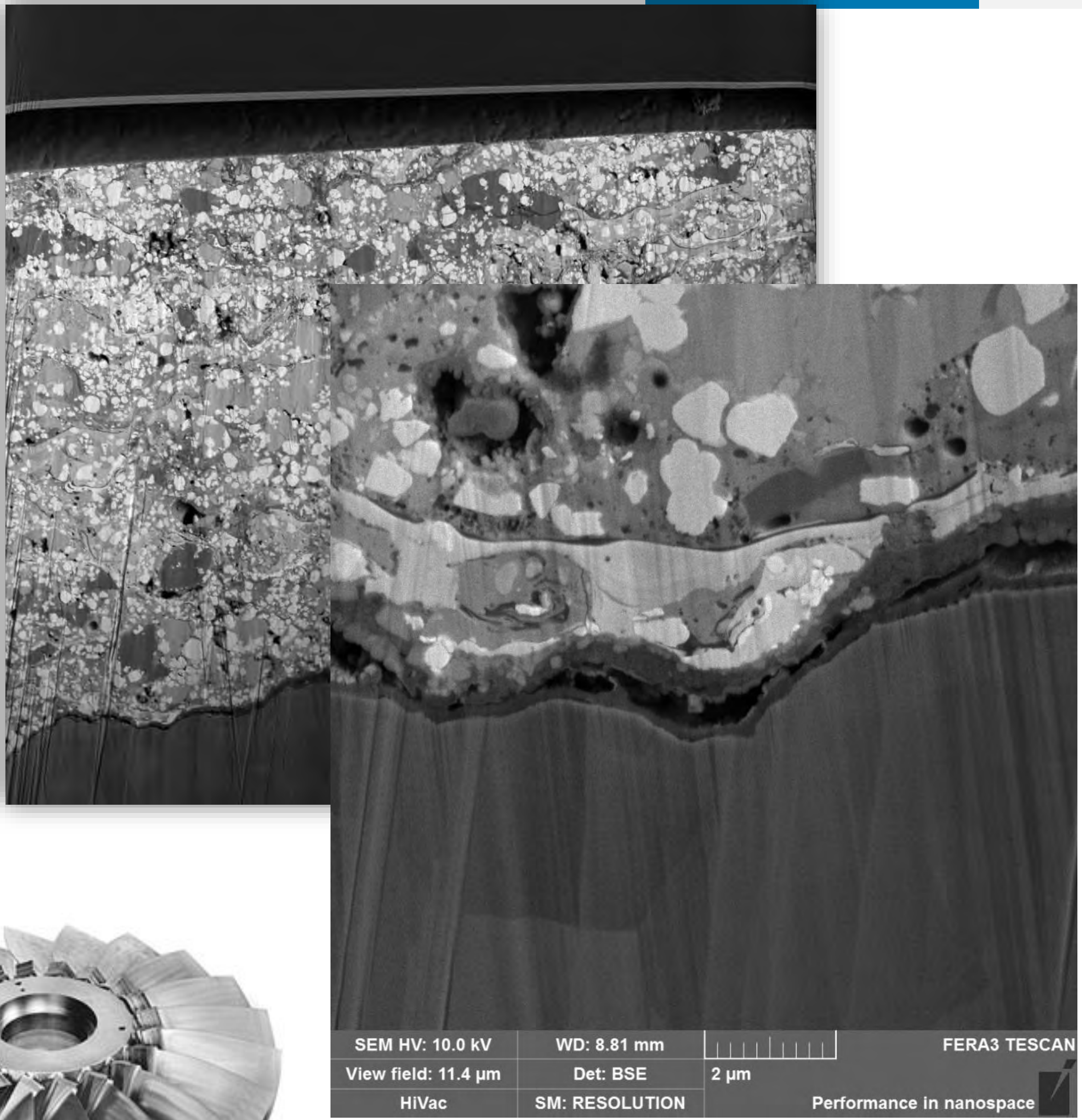
- **Hardcoating for aircraft turbine blade - cross-section**



Hard material layer on gray cast iron

40 µm nickel

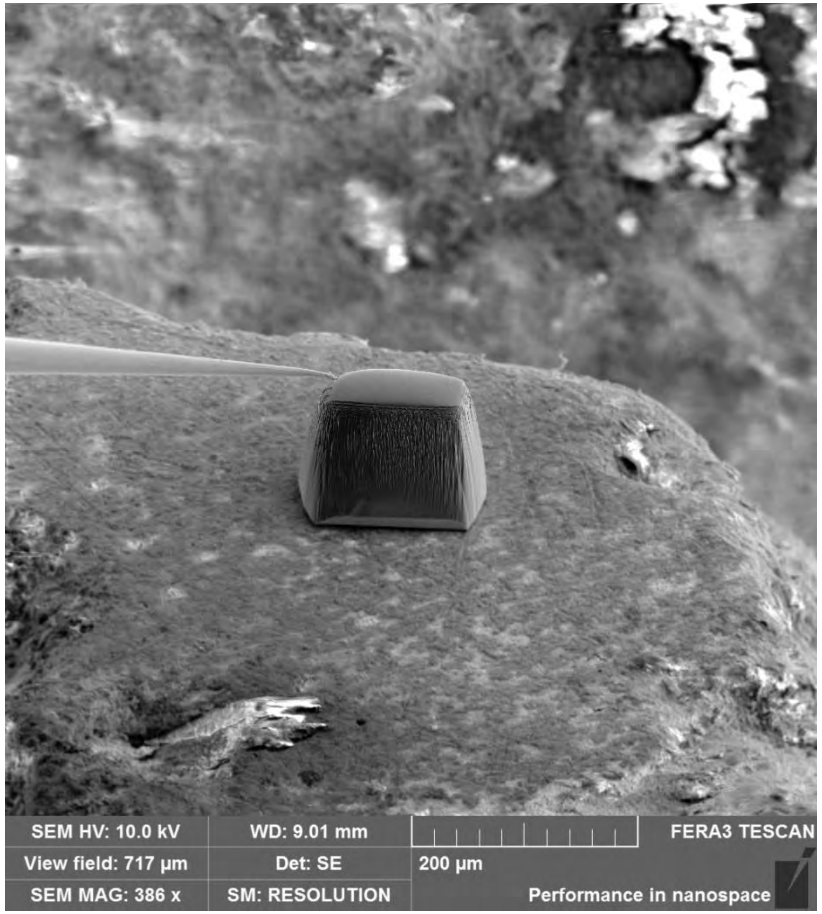
2 h

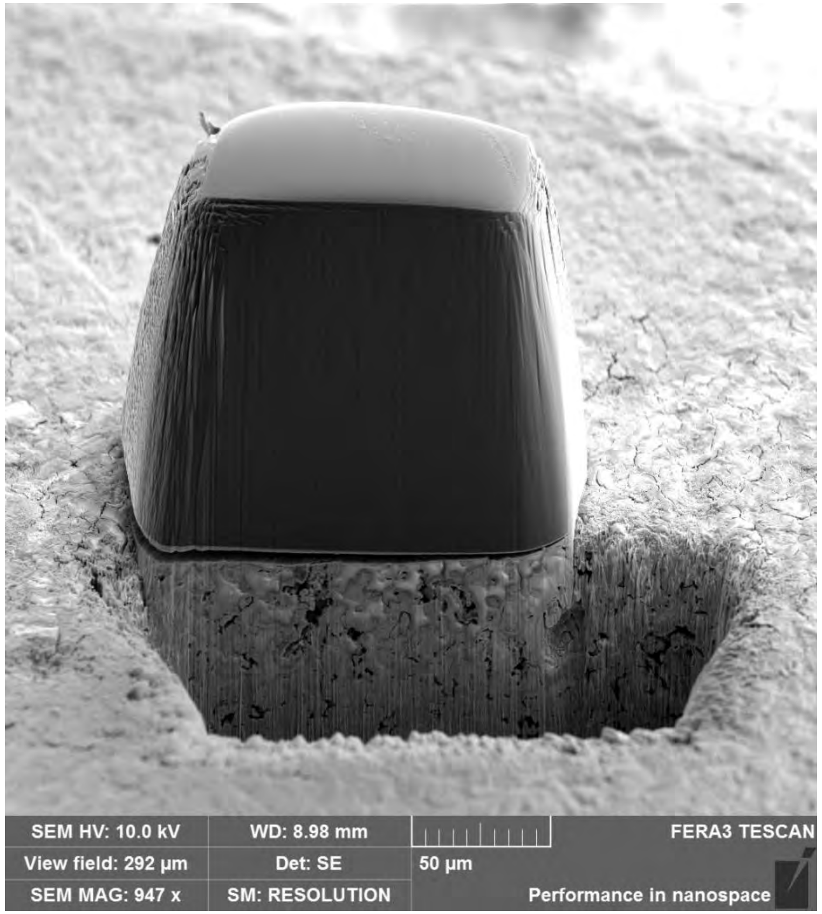


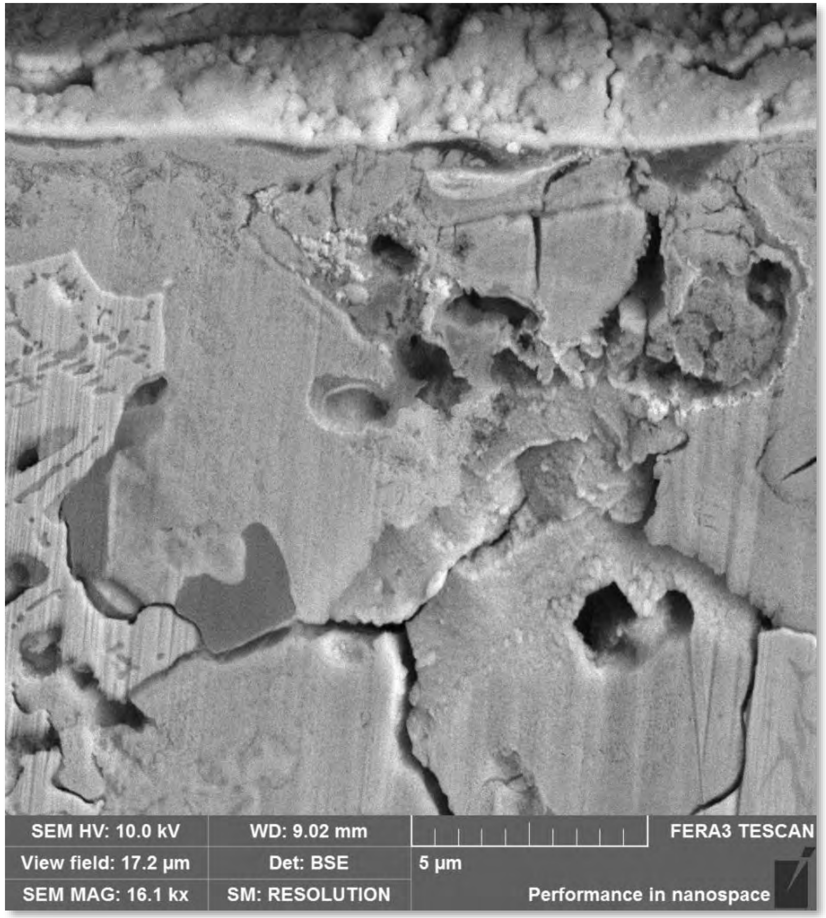
Detailed image of the hard coating

Xe⁺

- Cross-section of 2000 years old Romanian coin



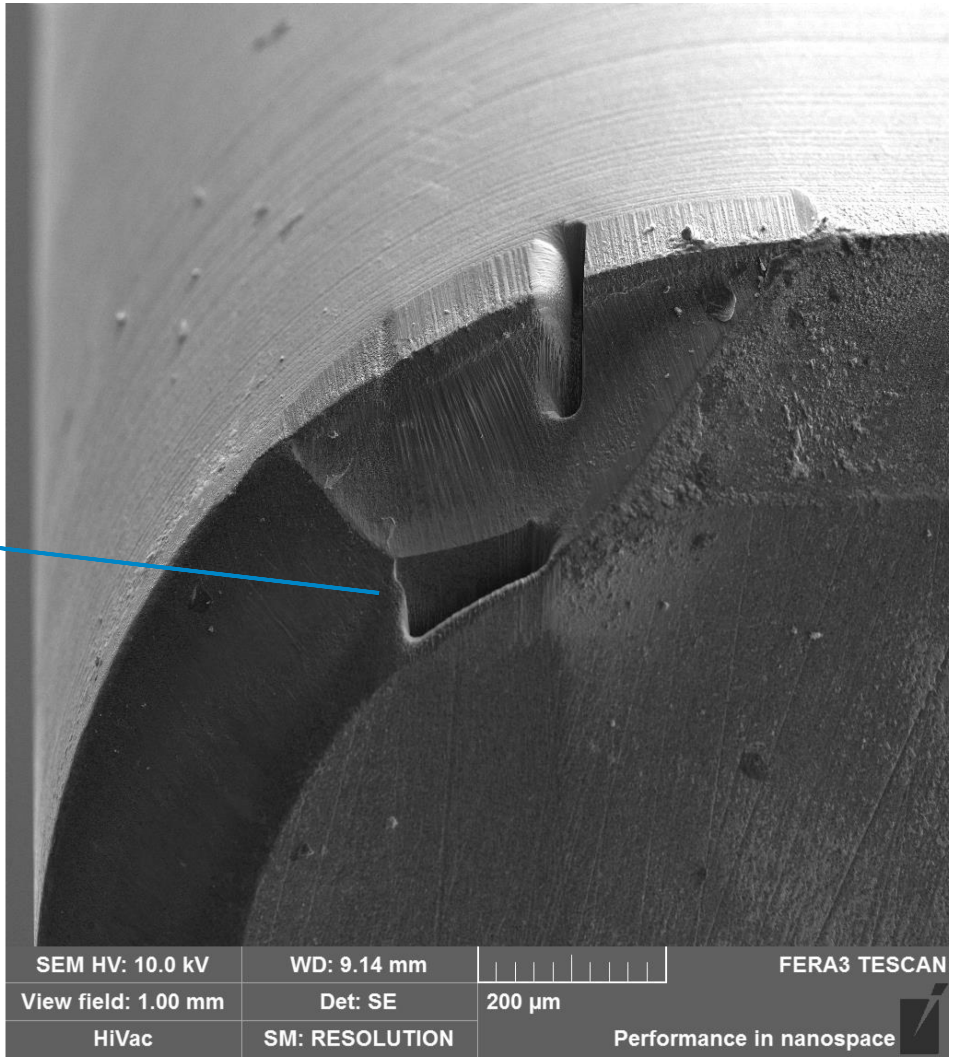




- Trench milling at 2 µA with silicon mask, 10 minutes

Xe⁺

- Cutting tool – boron nitride cross-sections

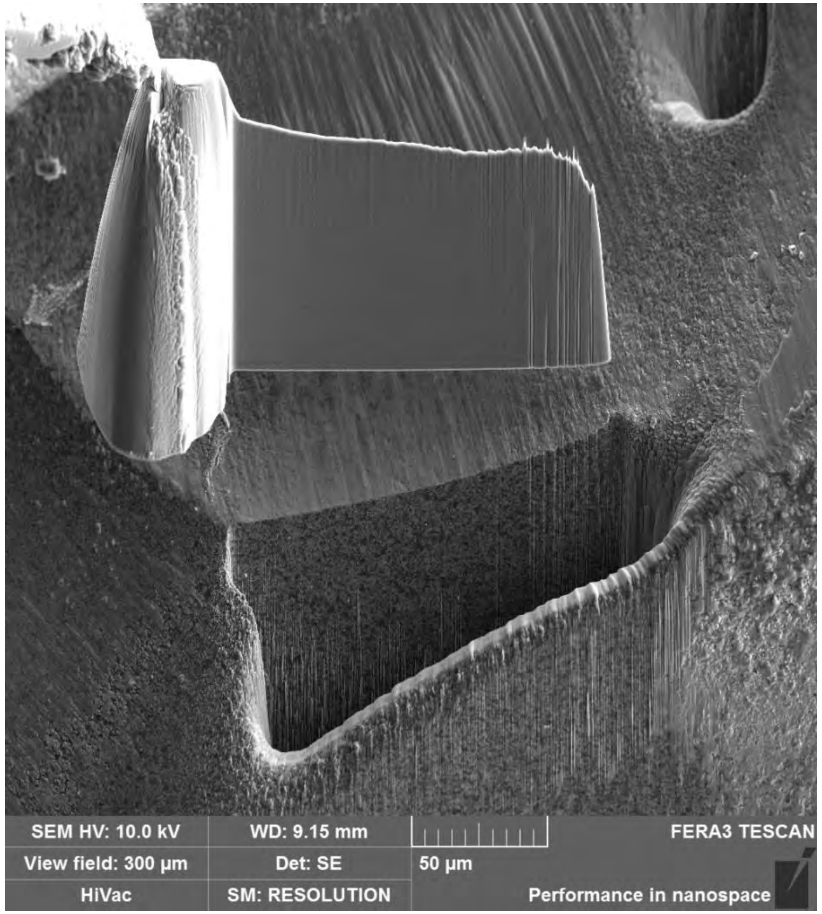


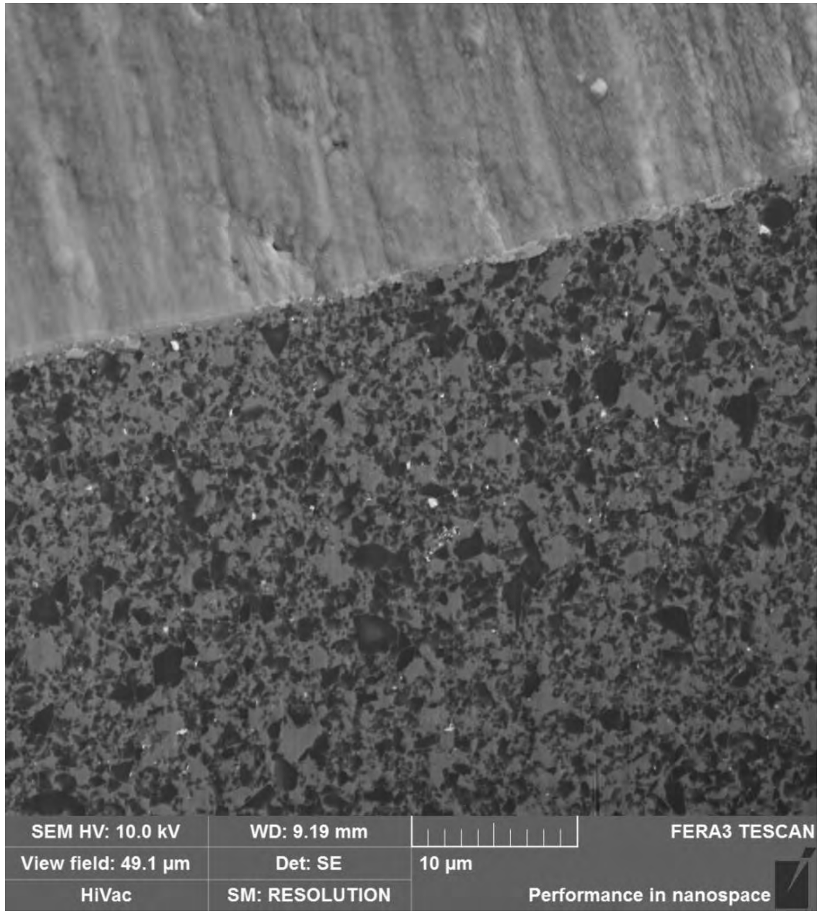
- Trench milling – 15 minutes at 2 uA with the silicon mask
- Rough polishing – 25 minutes at 300 nA
- Final polishing – 20 minutes at 100 nA

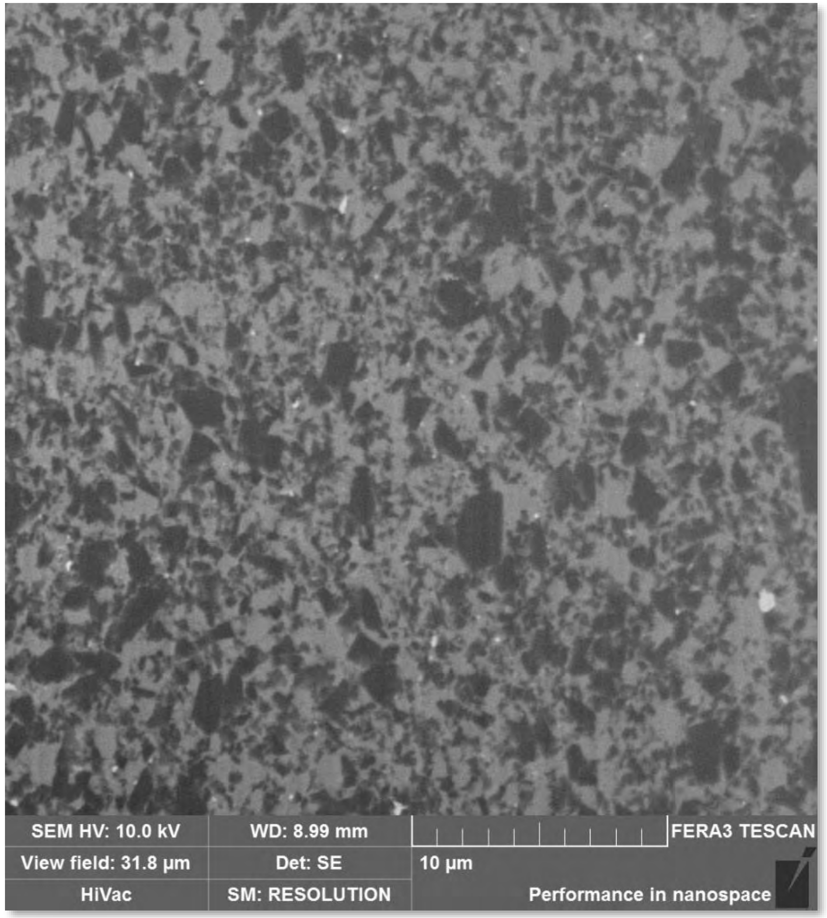
- Large delamination in cutting tool

Xe^+

- **Cutting tool – boron nitride cross-section**

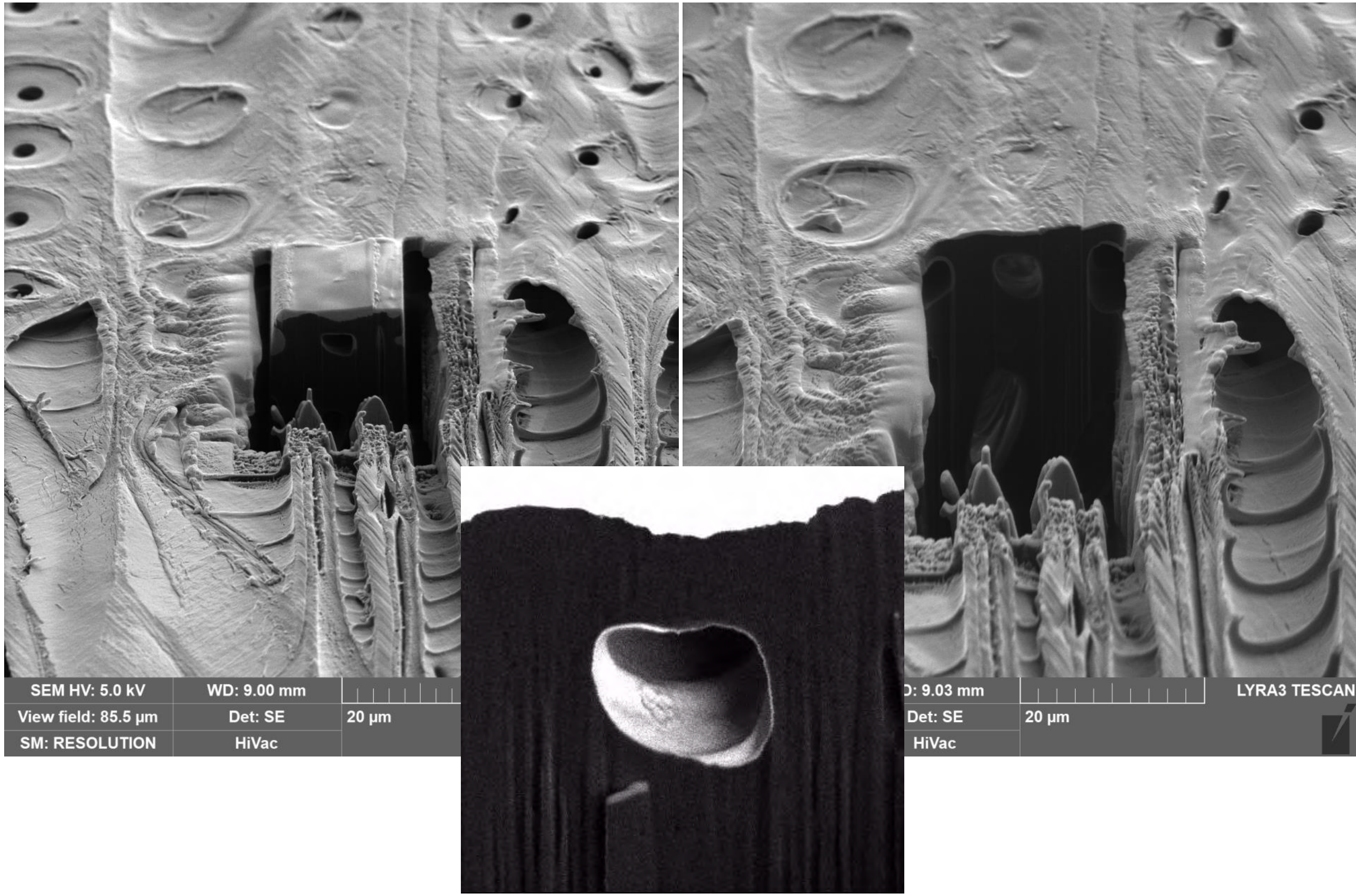






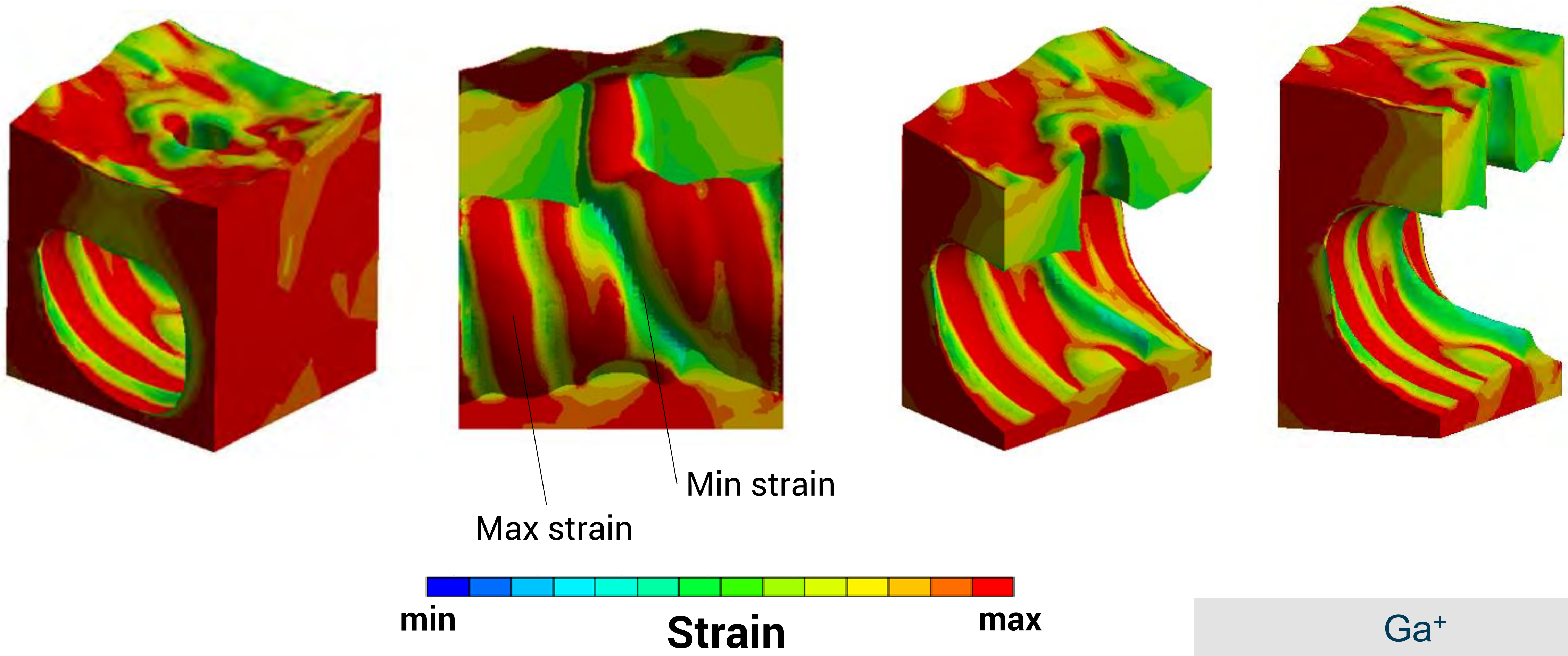
Ga^+

- **Wood - Taxus – 3D tomography**
  - **15×15×15 µm^3 with 20 nm pixel size**
  - **Trench: 17 nA current – 13 minutes**
  - **FIB slicing: 820 pA – 1.52 hours**
  - **SEM imaging 41 minutes**
  - **Total time: 2.33 h**



Ga^+

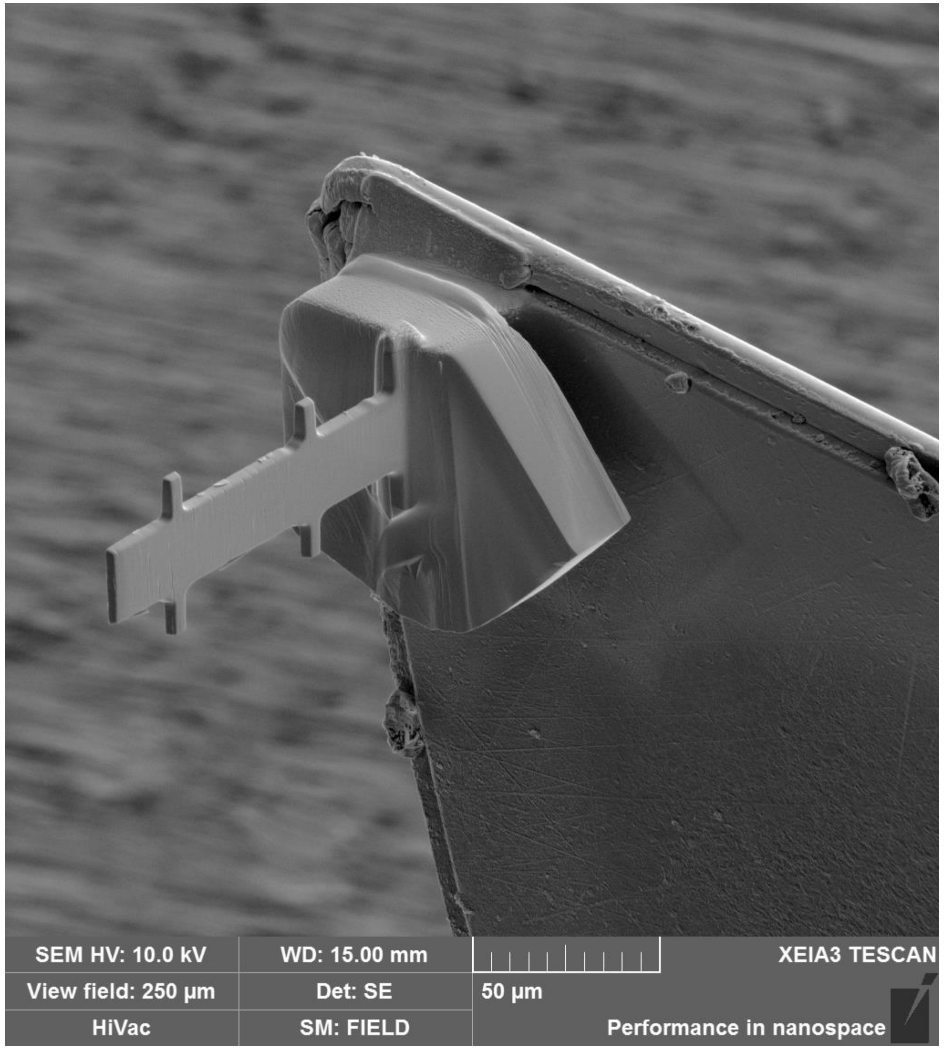
- **Wood - Taxus – 3D tomography**



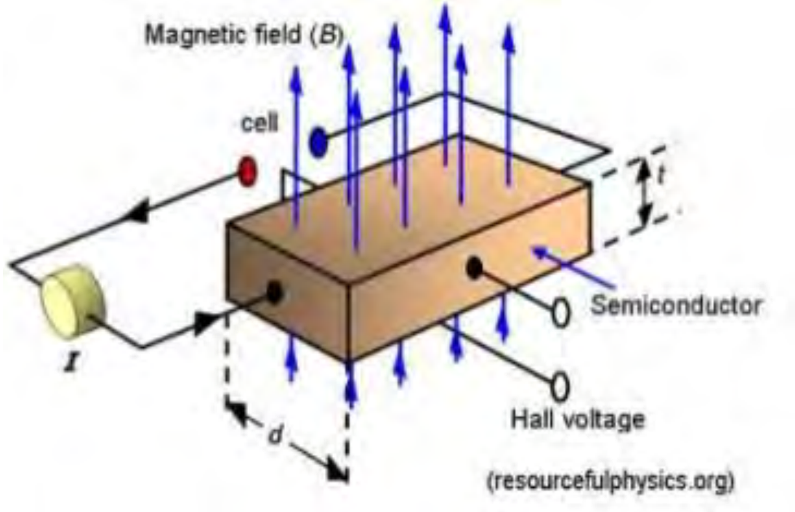
Ga^+

Xe⁺

- **Hall probe from planar lamella preparation**



$$F = q[E + (v \times B)]$$

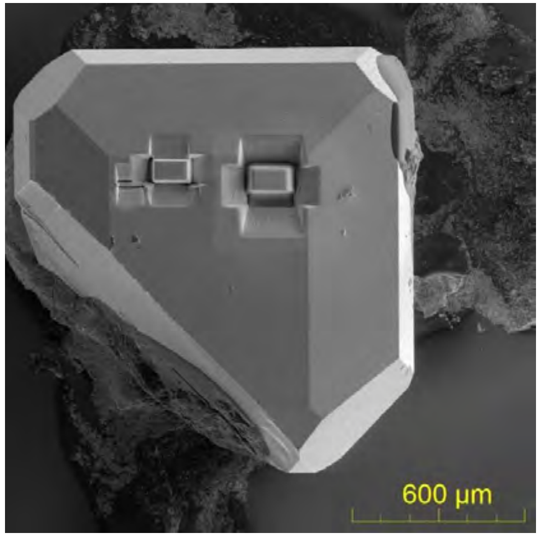


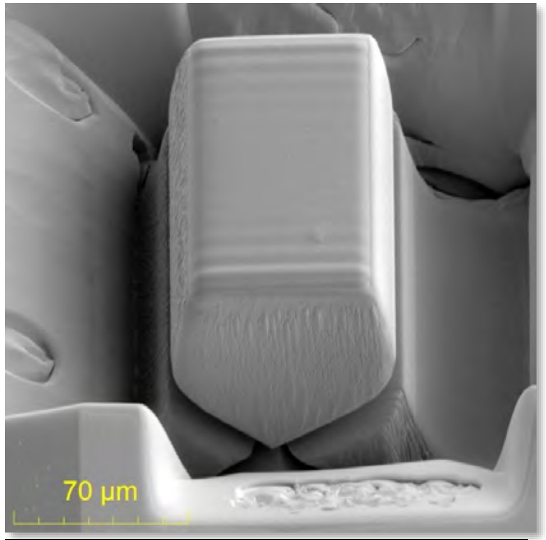
- **Hall voltage is produced by charge accumulation on sidewalls**
- **Charge accumulation balances Lorentz Force**
- **Charge accumulation increases resistence**

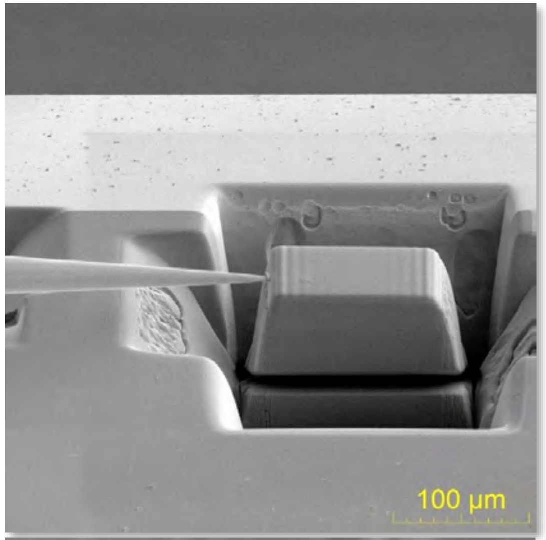
- **Image of the Hall probe prepared by Plasma FIB.**
  Total preparation time: 3 hours

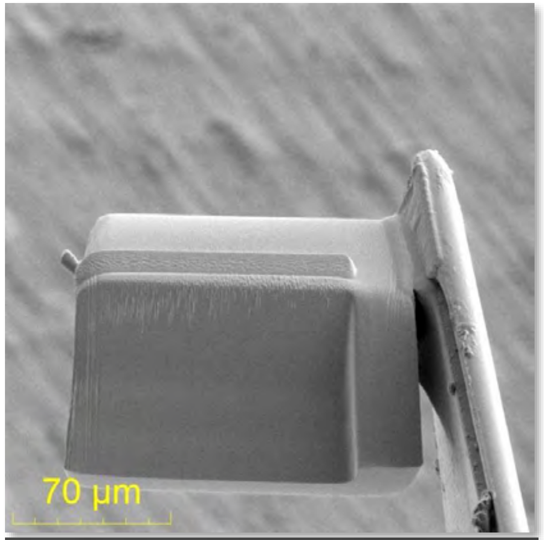
Xe^+

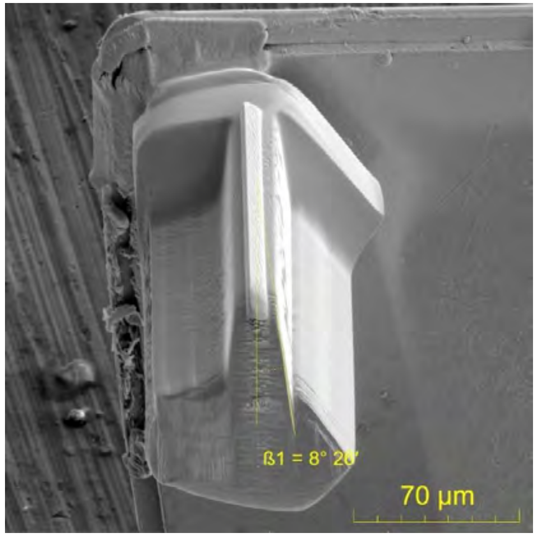
- **Hall probe from planar lamella preparation**

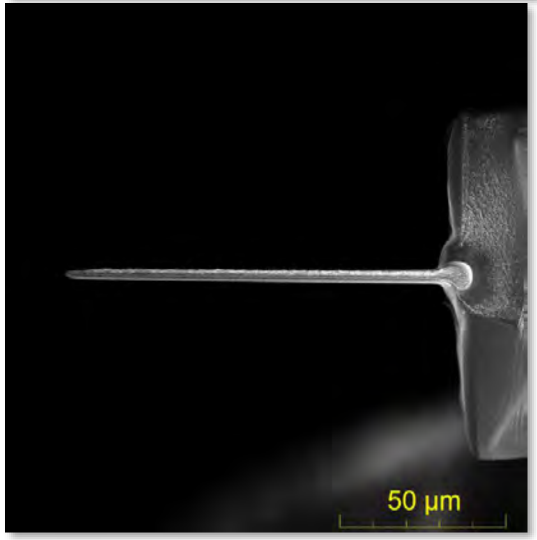


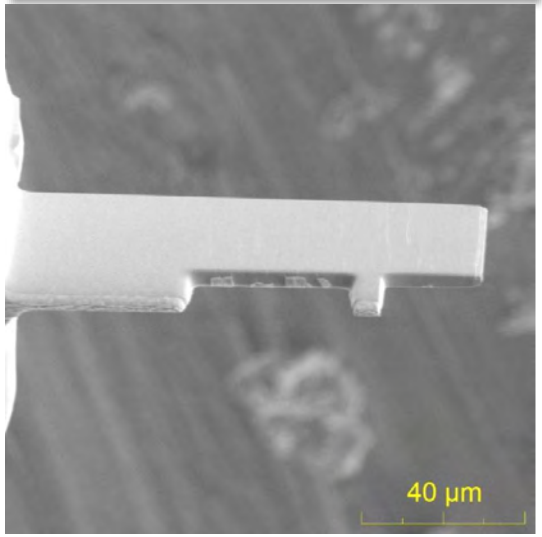


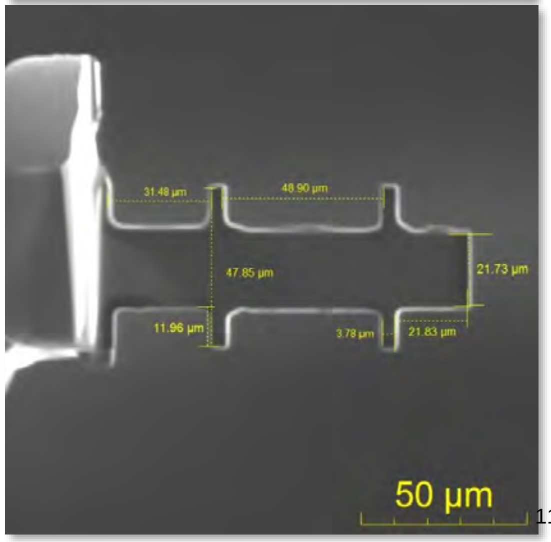






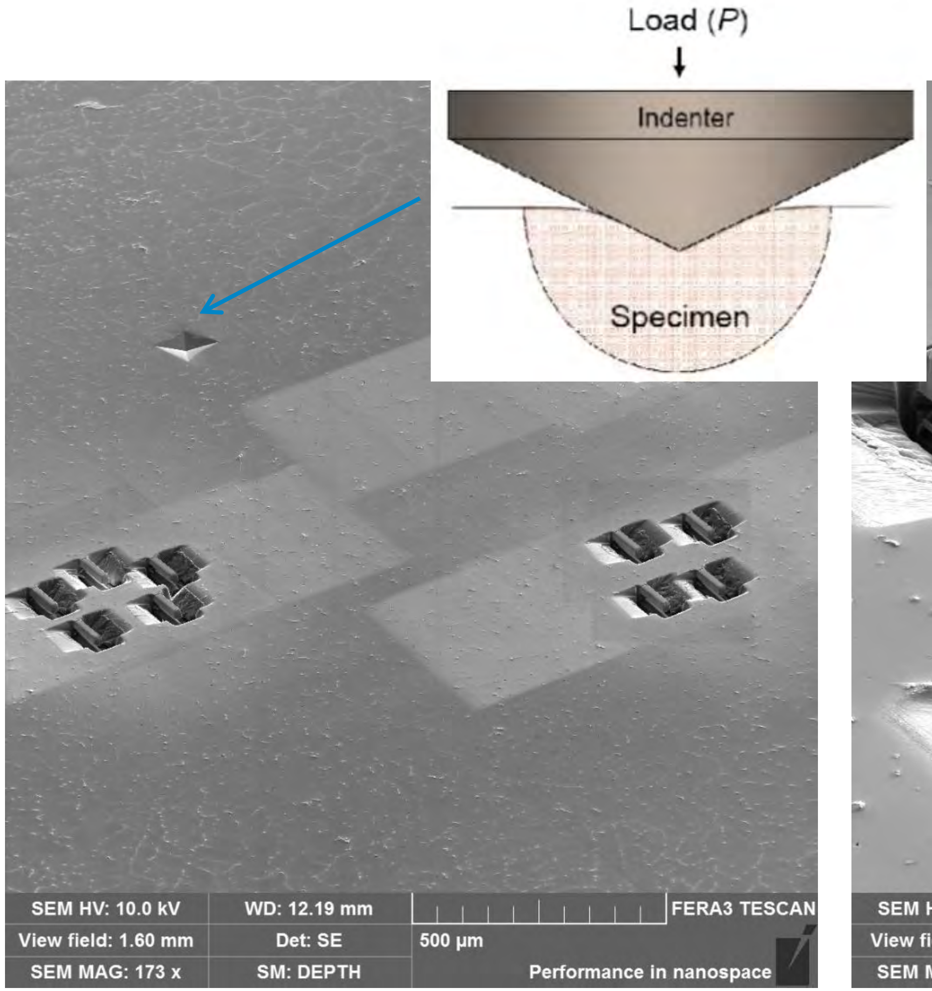


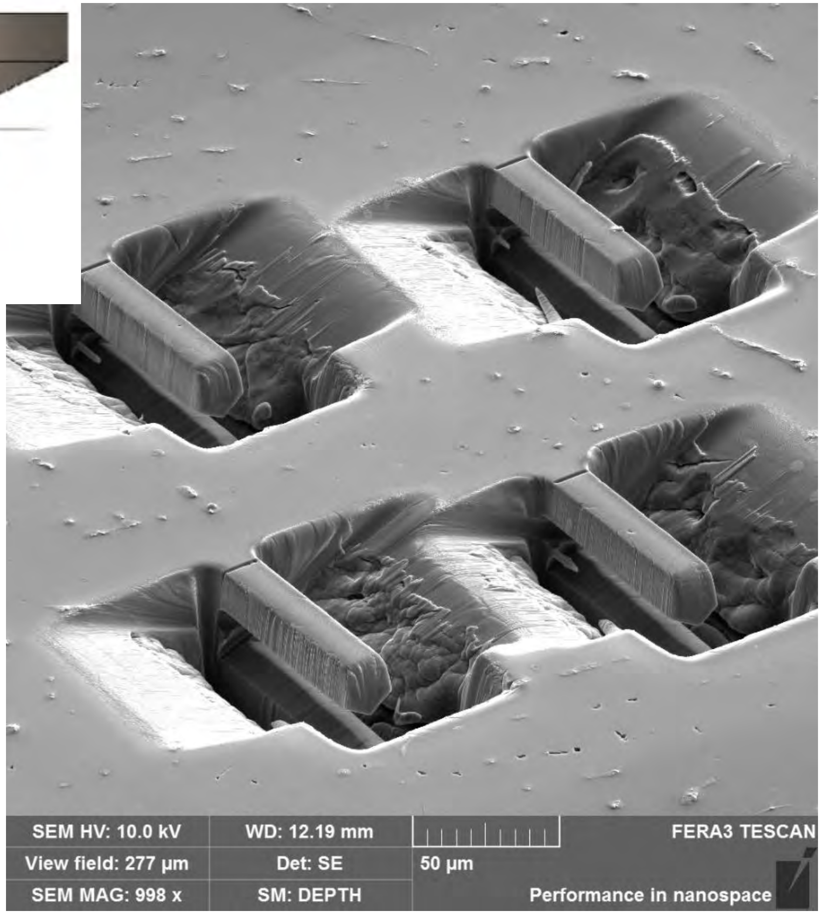


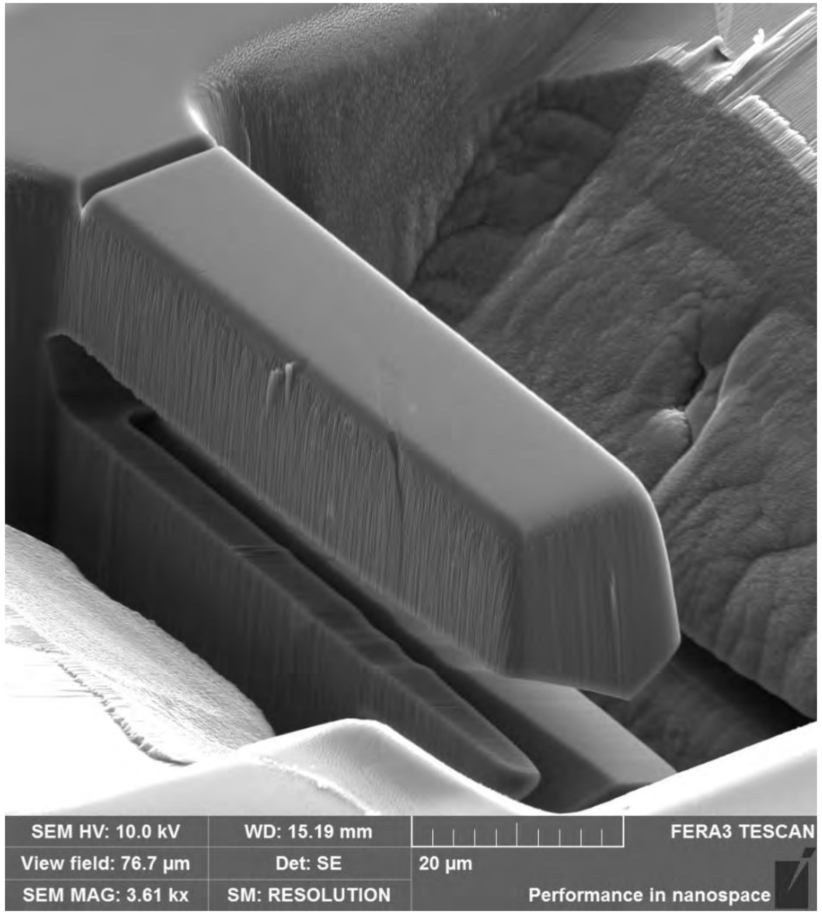


Xe^+

- **Array of identical micro-cantilevers for high temperature fracture testing**



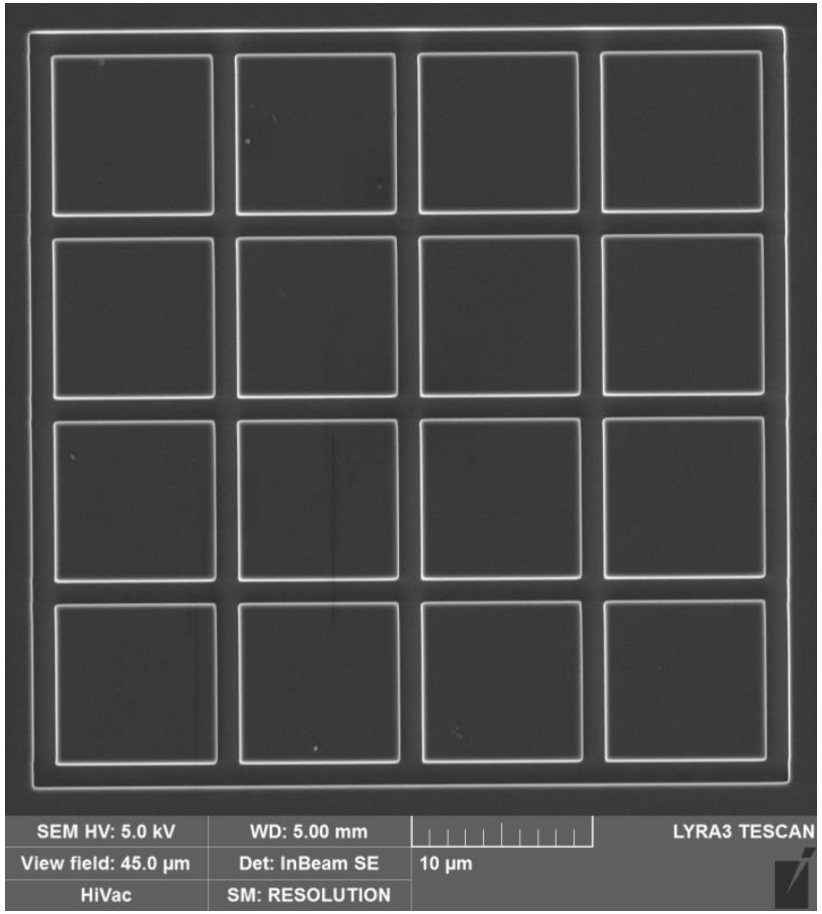




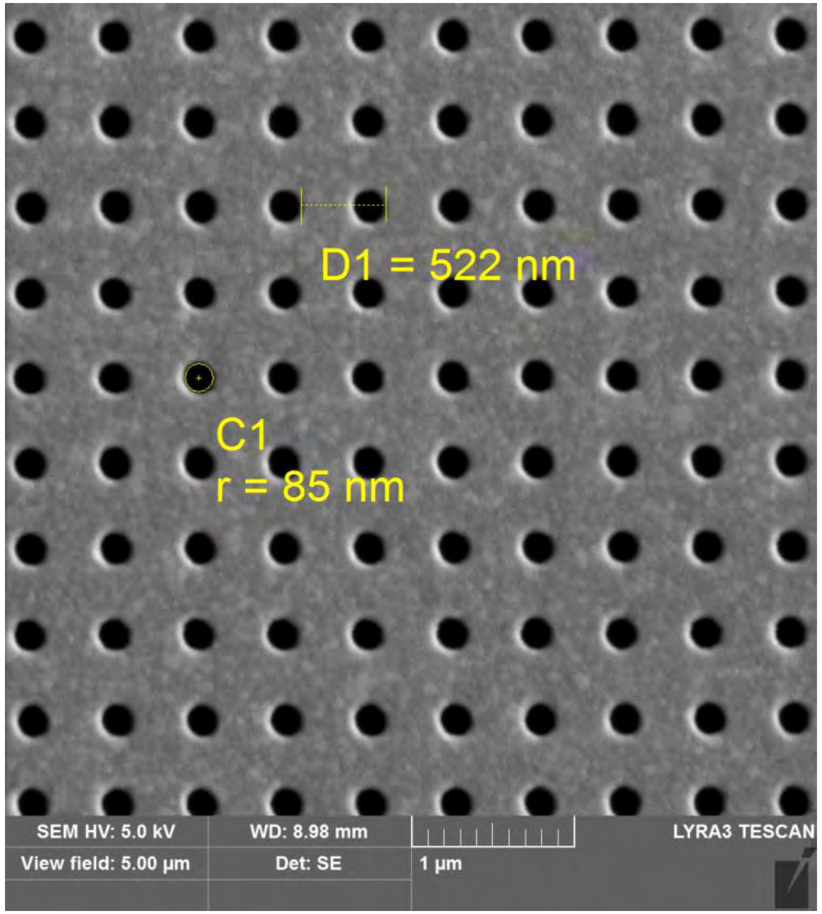
- **Magnesium sample**

Ga^+

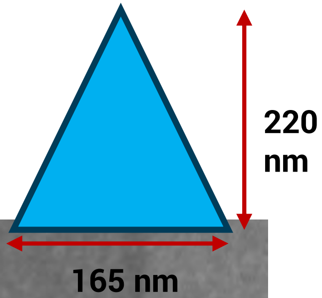
- Micro/Nano Patterning

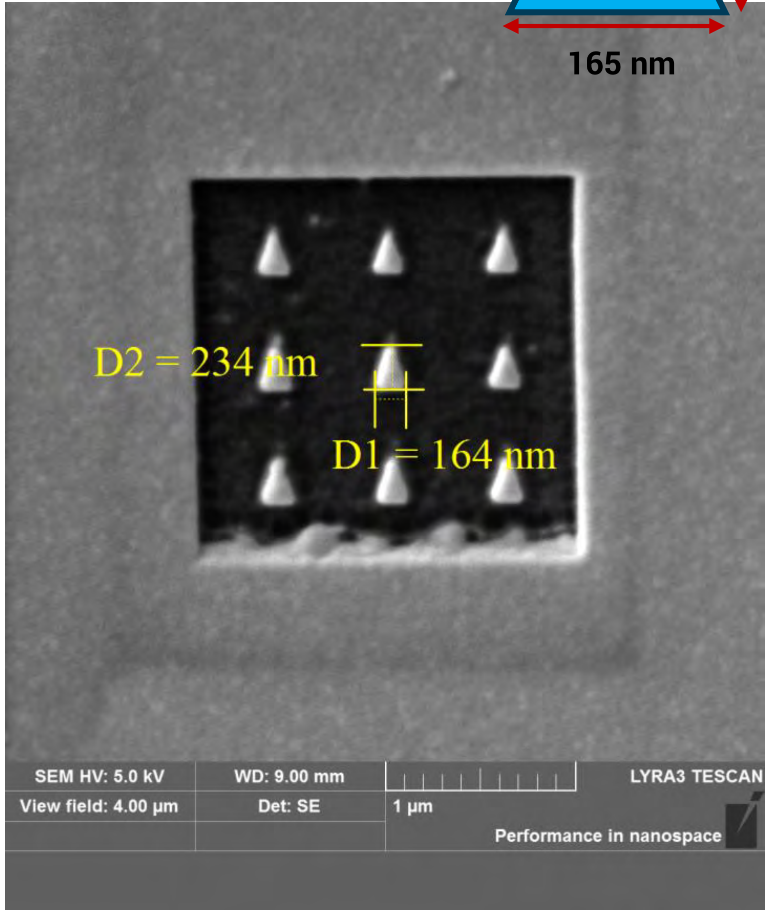


- SiC Wafer



- Glass substrate with Au

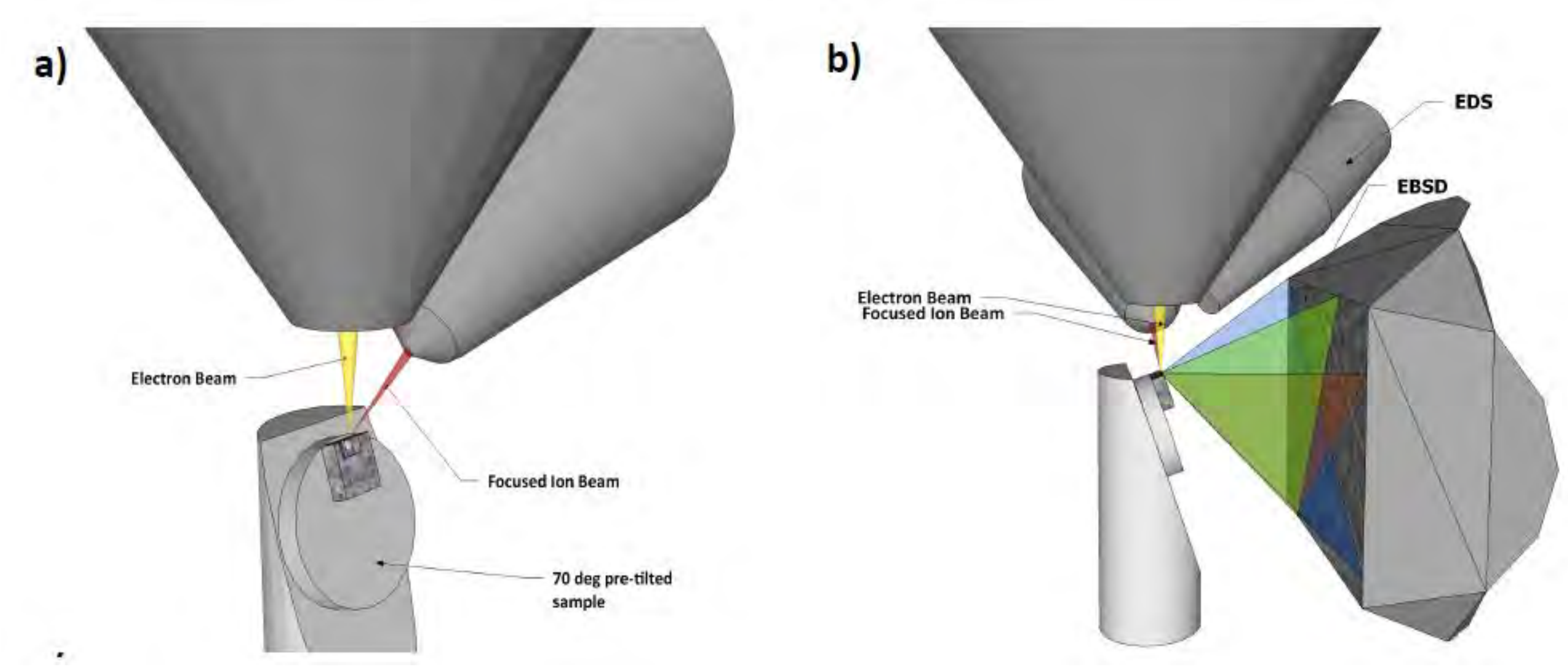




- Glass substrate with Al

ADVANCED TECHNIQUES
3D EDX and EBSD
TOF-SIMS
AFM

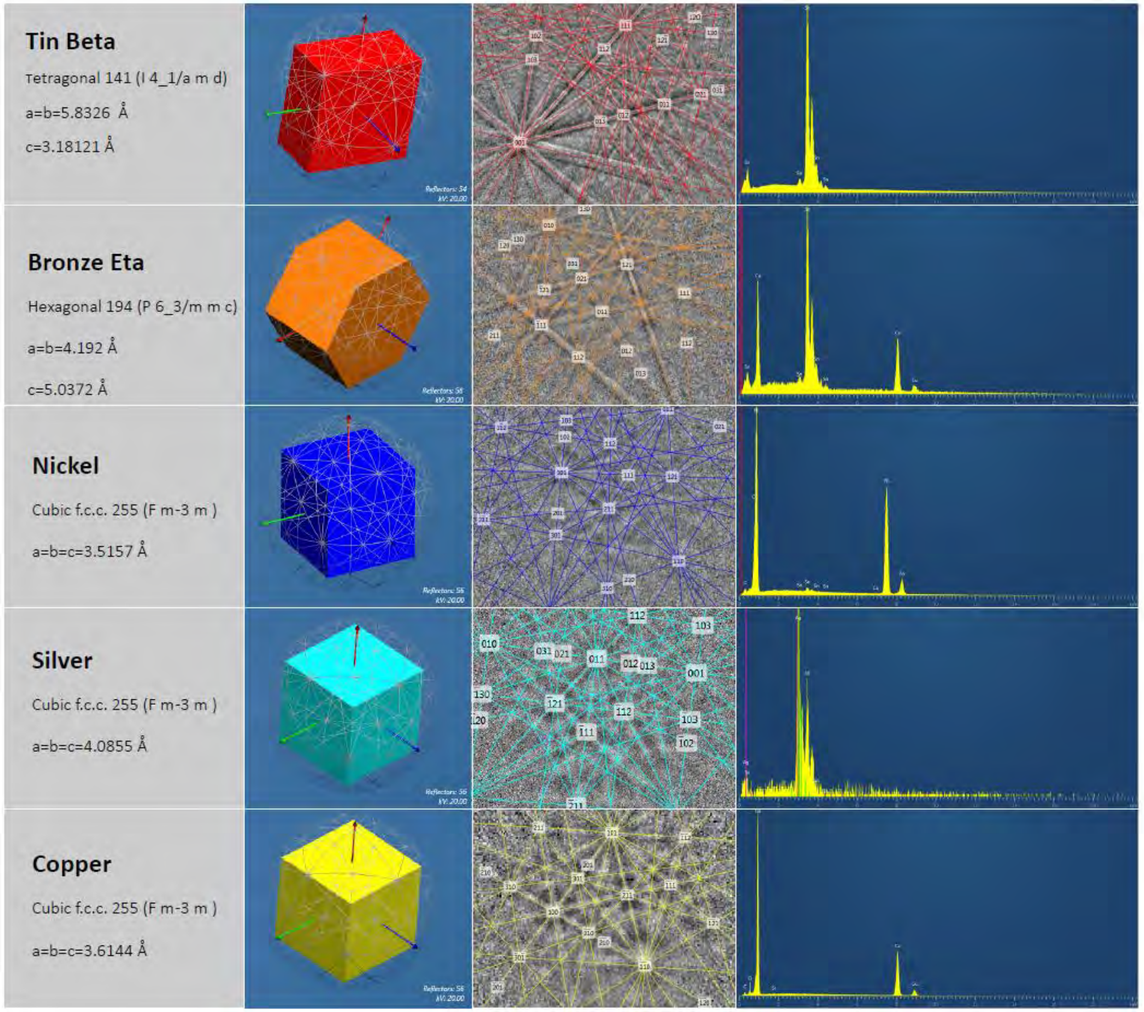
3D EDX and EBSD



TESCANs Unique Static 3D EBSD +3D EDS Acquisition

Advantages of Simultaneous EBSD+EDS (especially in 3D)

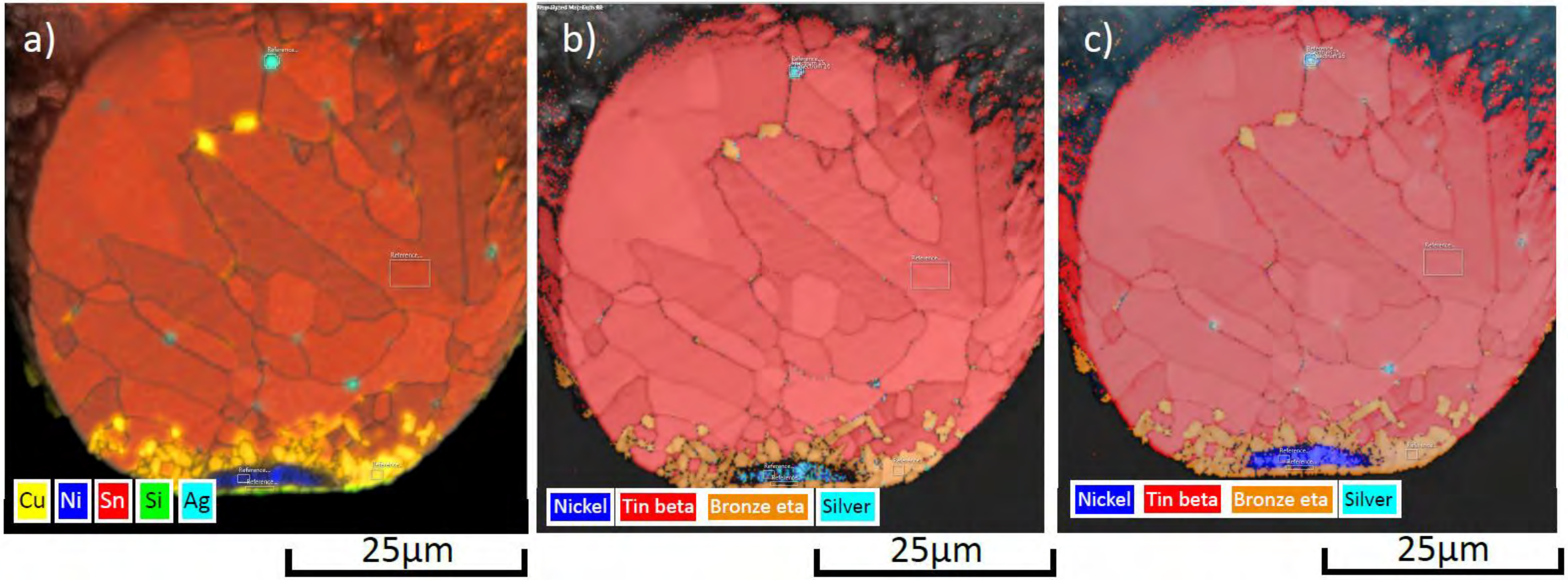
- Phases with similar crystal structure are sometimes difficult to distinguish only using EBSD
- EBSD phase identification with the help of EDS reference spectra can be set (OI TruPhaseTM)
- Online EBSD identification aid with the use of EDS data is benefitial especially for 3D EBSD
- EDS data can be stored together with EBSD for additional 3D data information



Example of possible phases in solder bump Cu and Nickel has similar f.c.c. grid

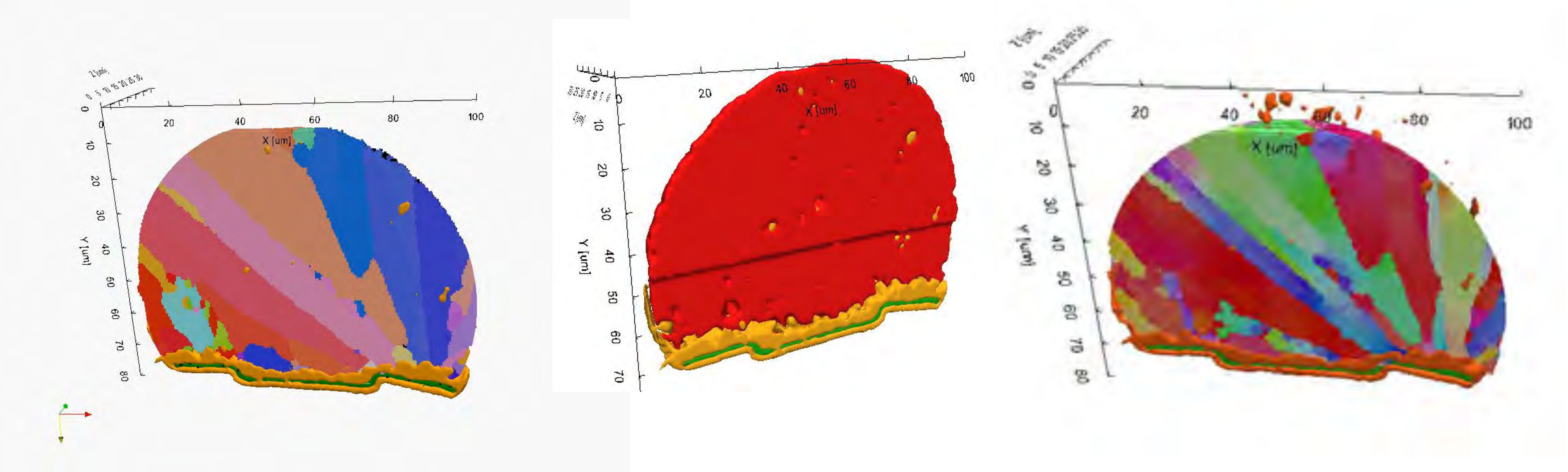
Simultaneous 3D EBSD + 3D EDS

- **Solder Bump**



- **Comparison of different phase analysis techniques: a) EDS map using TruMap™ deconvolution b) EBSD identification without using the EDS signal and c) TruPhase™ mapping result with reference spectra used for phase identification correction on phases with a similar crystal latice**

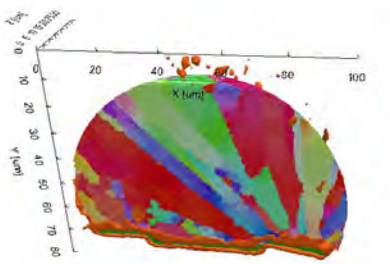
Simultaneous 3D EBSD + 3D EDS

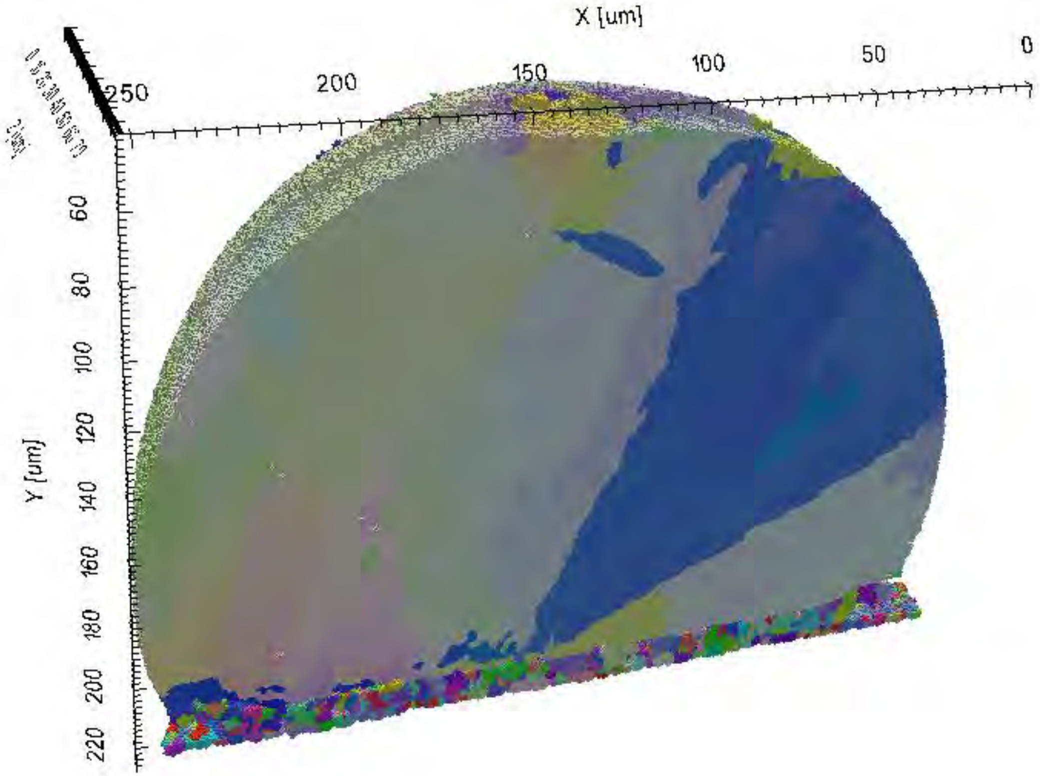


- Combined 3D EBSD and 3D EDS reconstruction of a 90 um solder bump
- Tin phase shown in IPF-Z mapping (EDS - red), Copper (EDS - orange) and Nickel (EDS - green) isofurfaces extracted from 3D TrueMap^{TM} data
- Visualized using ParaView

Ga⁺ FIB vs. Xe⁺ PFIB for 3D EDS and 3D EBSD

- **What can be acquired in a reasonable amount of time?**



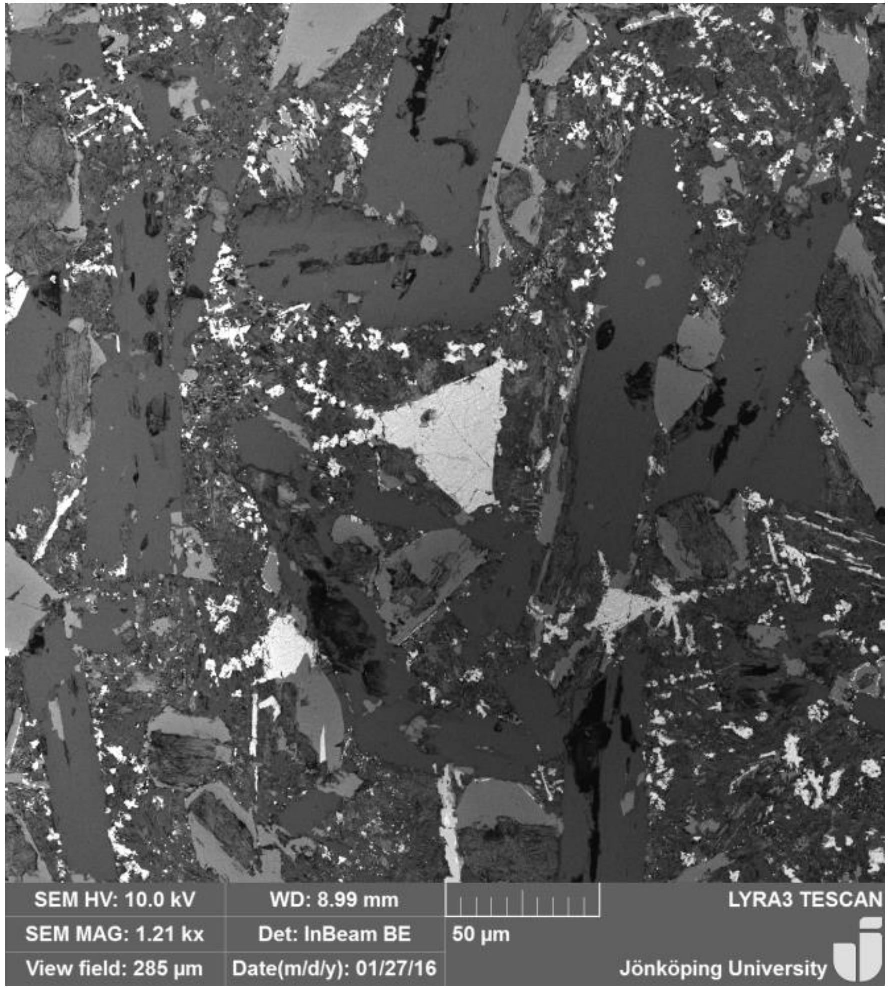


- **3D EBSD of 90 µm solder bump acquired on Ga⁺ FIB (over a weekend)**
- **3D EBSD of 250 µm solder bump acquired on Xe⁺ FIB (over a weekend)**

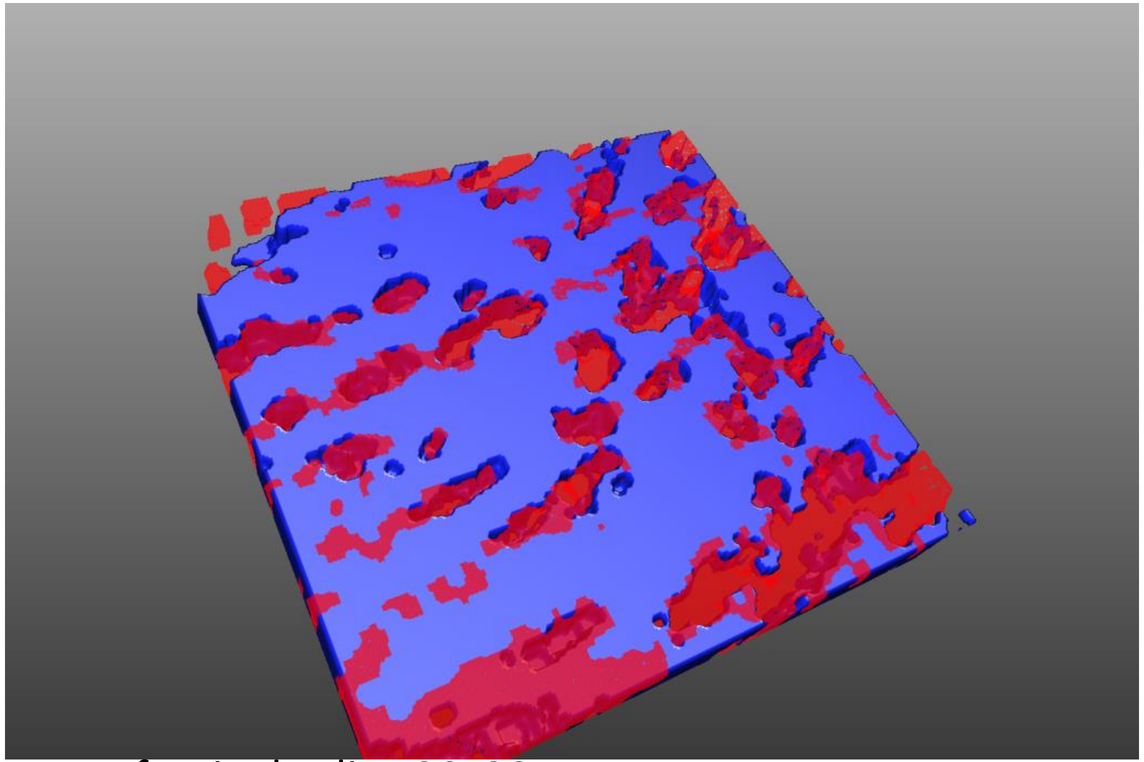
3D EDX

Ga$^+$

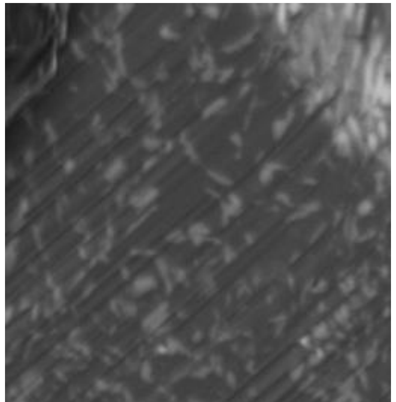
- **Study of Volcanic Rock Sample**

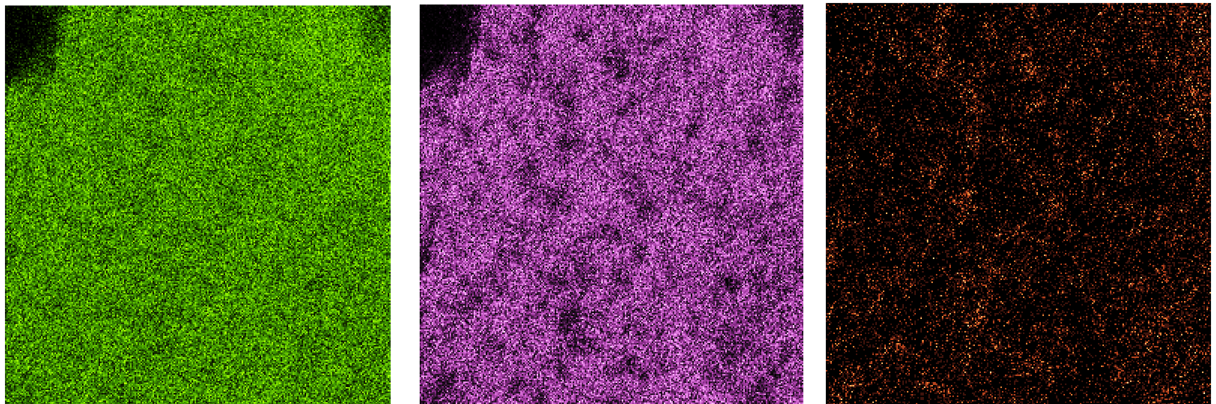


3D EDS Volume Reconstruction:
Volume: 20x20x2,1 μm
Slice thickness: 300 nm
Slice time: 7.5 min



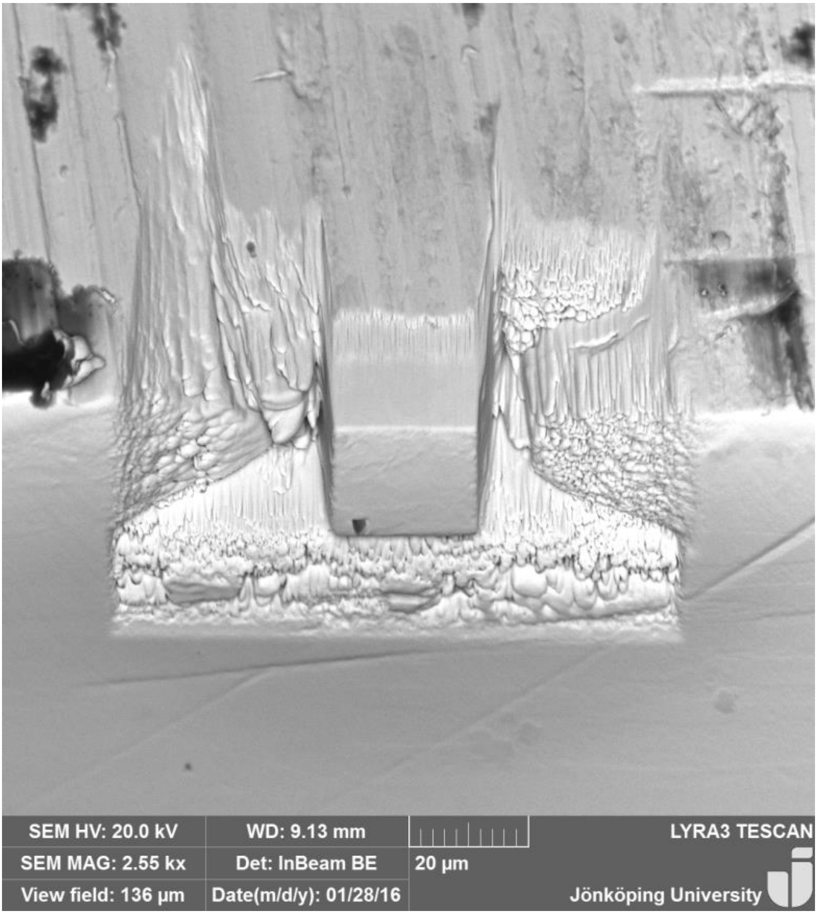
EDS map of a single slice 20x20 um





3D EBSD

- **Duplex Stainless Steel**

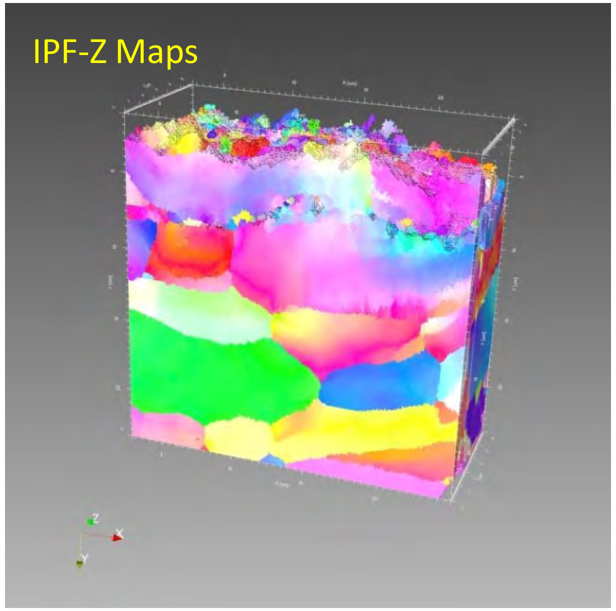


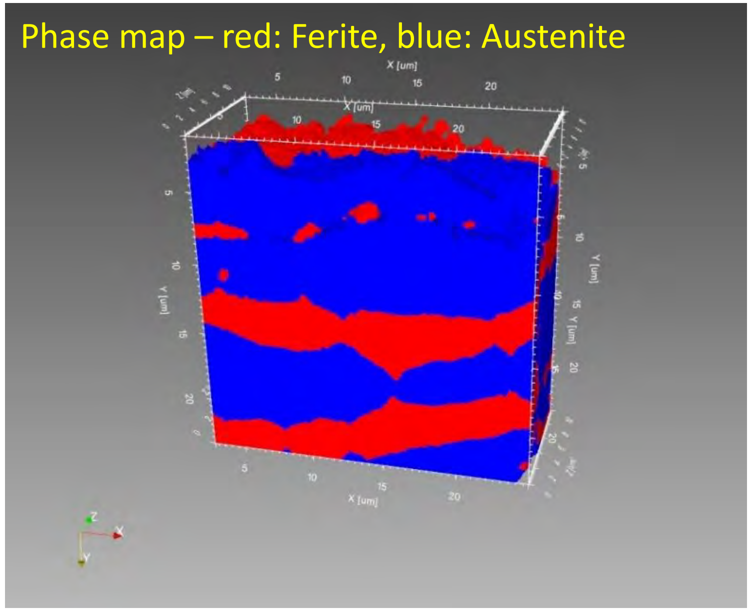
Pillar preparation – 1.5 hours with 23nA beam
Pillar size 25x25x10 um

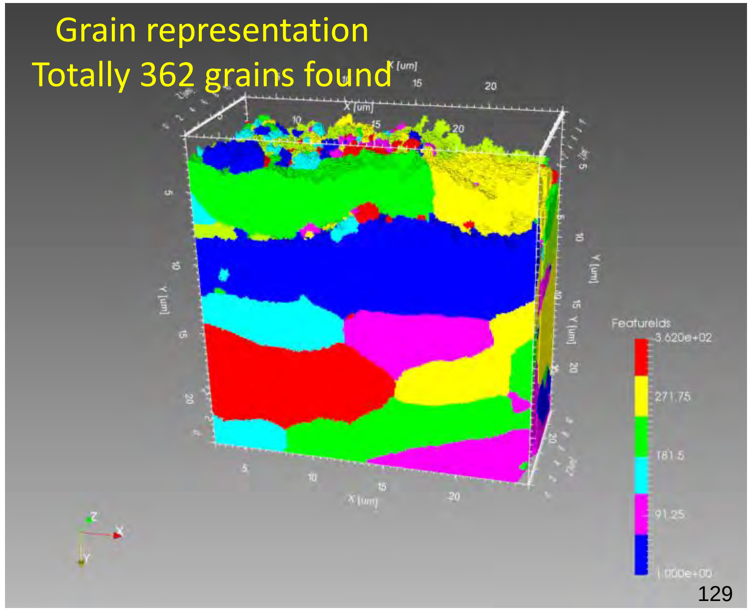
Ga+

Slicing setup:
FIB current: 1.4 nA
Slice thickness: 100 nm
Slicing time: 2.1 min
Number of slices: 100

Total acquisition time: 14.5 h



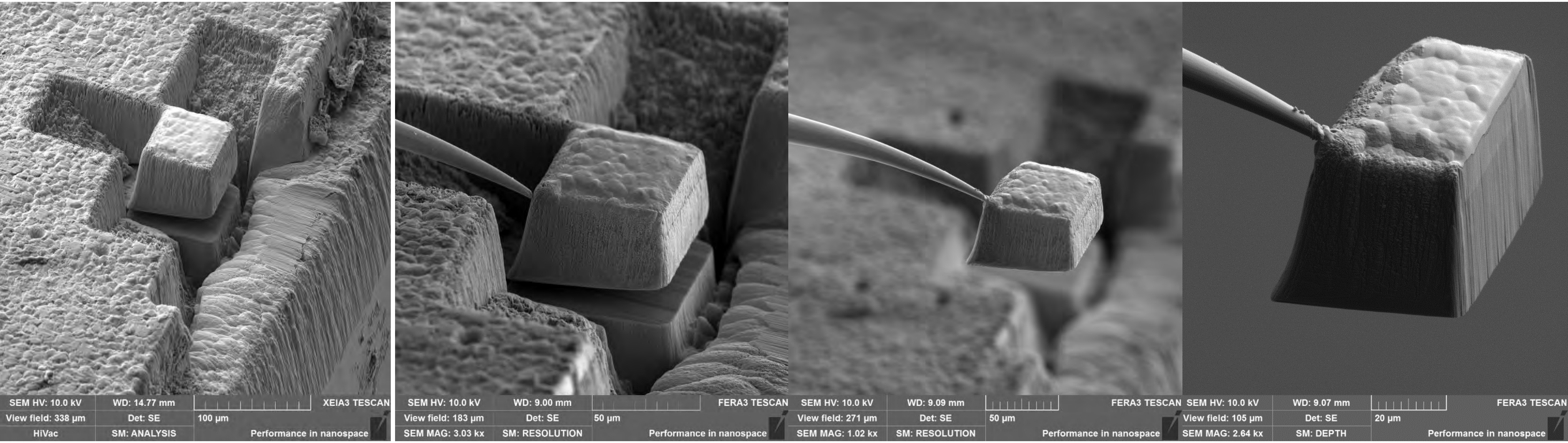




3D EDX and EBSD

Xe^+

- **Zn Coated Steel**



- **Tungsten deposition (50x50 µm^2)**

- **Cubic sample was prepared by 3 trenches milling, undercut - 300 nA cca 1.5 hour**

3D EDX and EBSD

Xe⁺

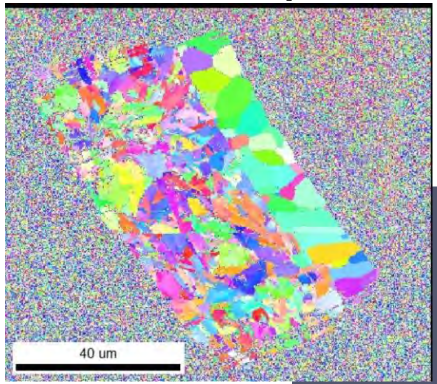
Zn Coated Steel

- **SEM**: (HV: 20 kV, Current: 6 nA)
- **EBSD: (**Step: 250 nm, Acquisition time:

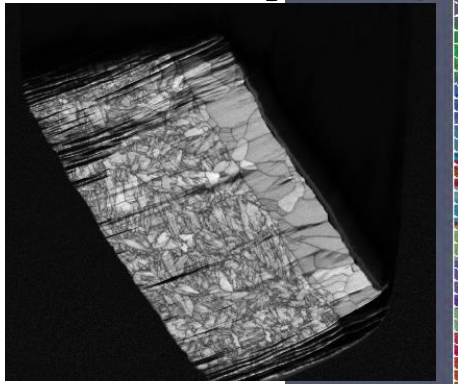
  10 min x 133 slices = 22 hours)
- **3D tomography process:**
  - Number of slices: 133
  - Slice thickness: 100 nm
  - Total volume: 60x50x13 μm^3
  - Beam current for slicing: 30 nA
  - Time for FIB slicing: 30 s x 133 slices = 1 hour

Total acquisition time: 23 hours

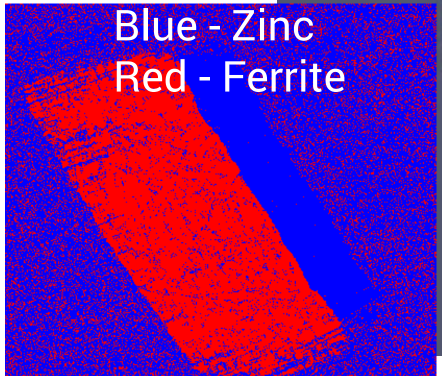
IPF map

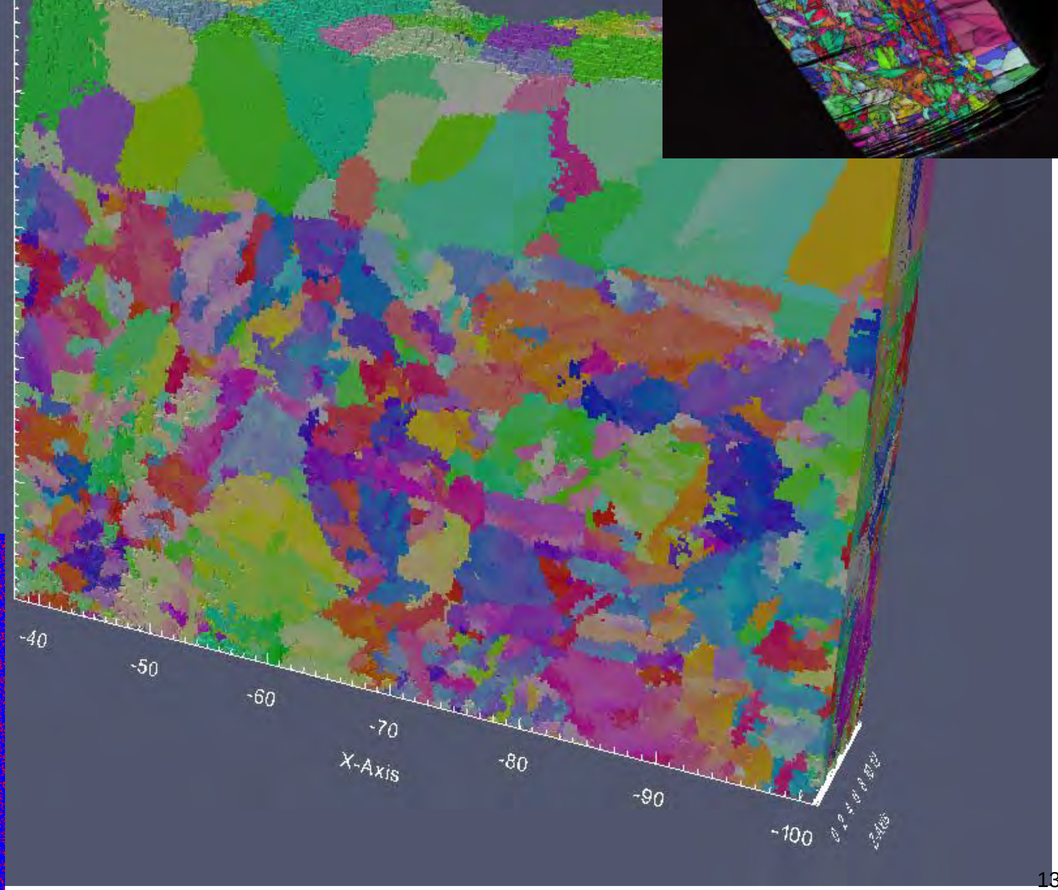


IQ image

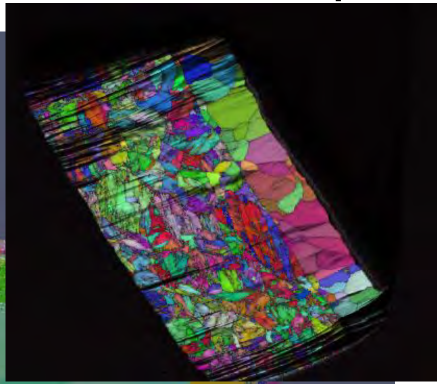


Phase map





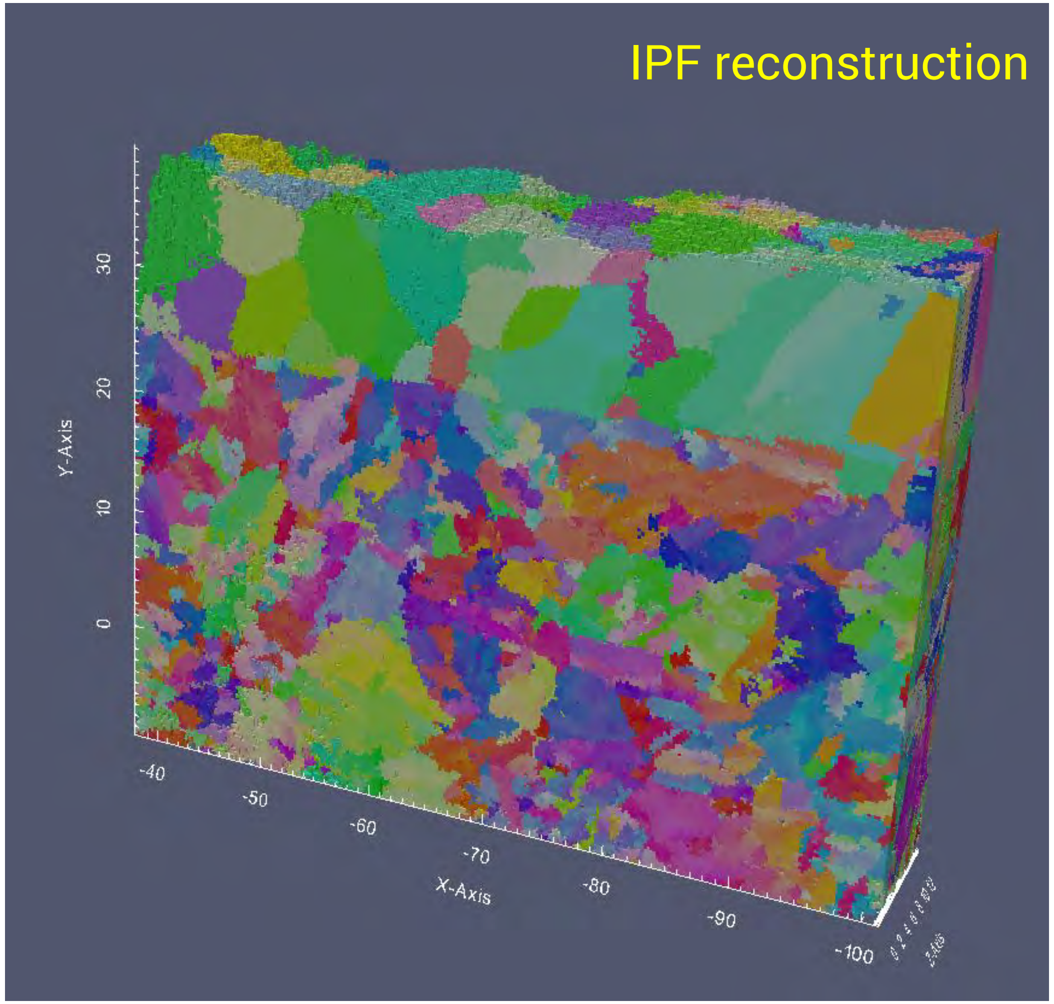
IPF+IQ map

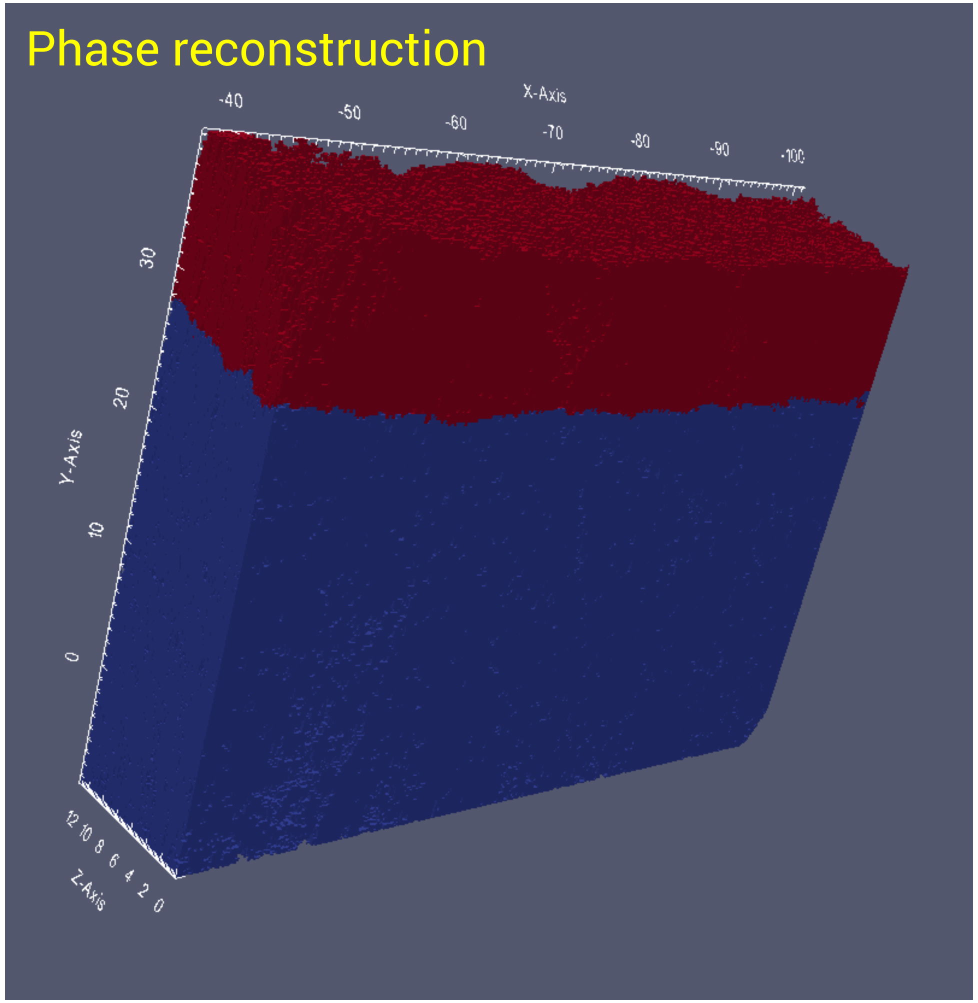


3D EDX and EBSD

Xe⁺

- **Zn Coated Steel**

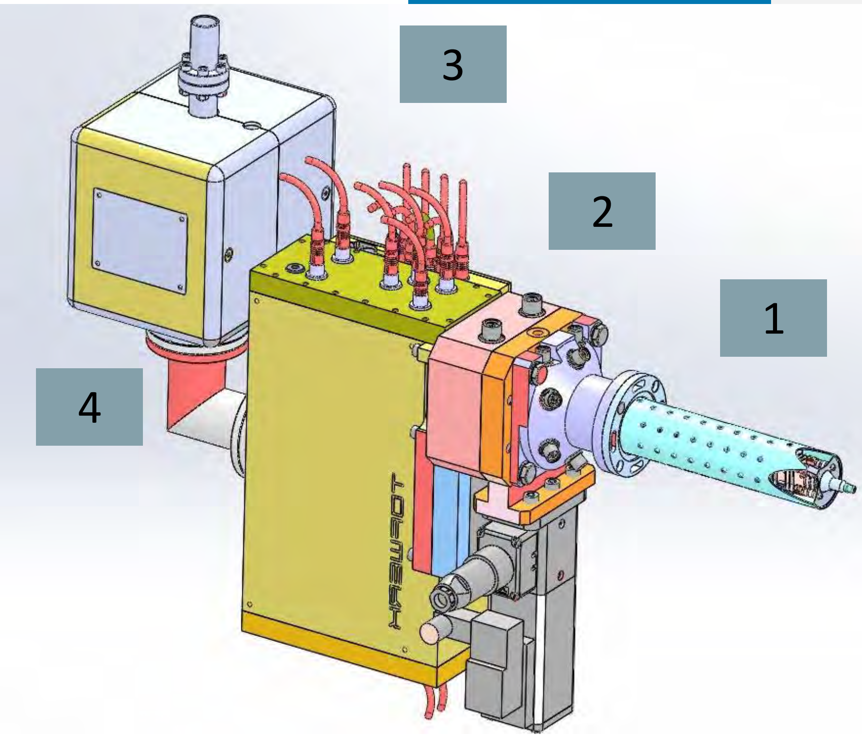




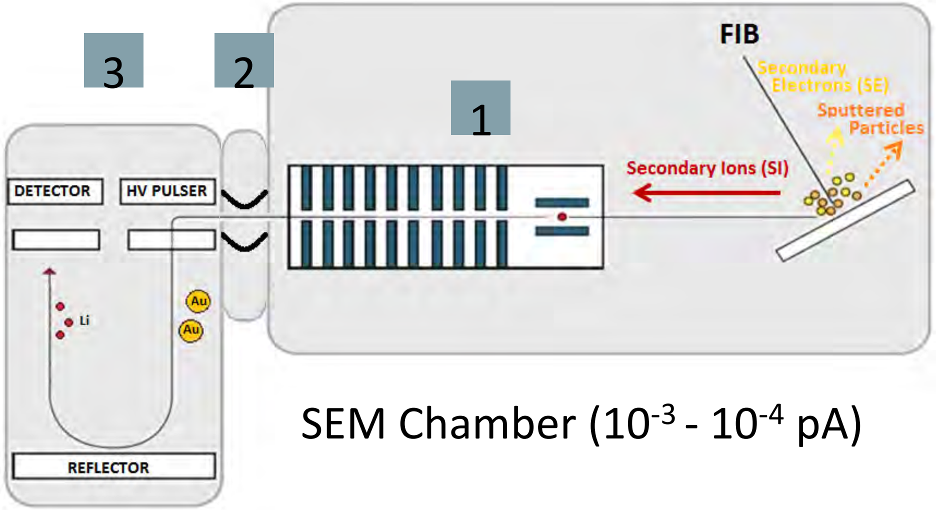
– processed by Dream 3D and ParaView softwares

TOF-SIMS

- **Ionisation by FIB (No need of another source)**
- **Secondary Ions are detected**
- **Ions are separated according to their m/Q**
- **Time of Flight is measured**
- **Positive or negative ion mode**



TOFWERK Time-of-Flight MS



SEM Chamber (10^{-3} - 10^{-4} pA)

1 Ion Transfer Optics
2 Separating valve

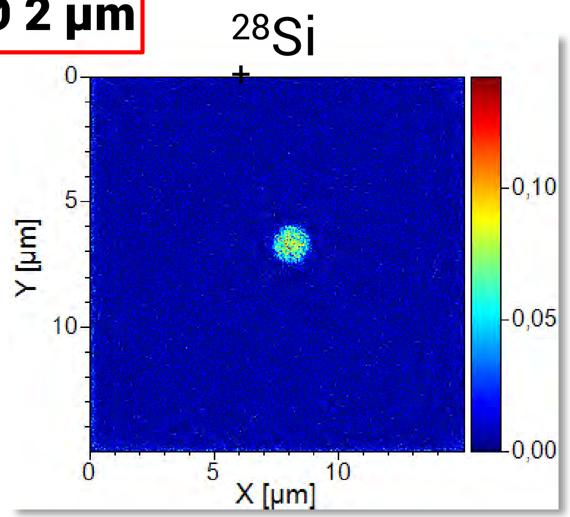
3 TOF chamber
4 TOF ion pump

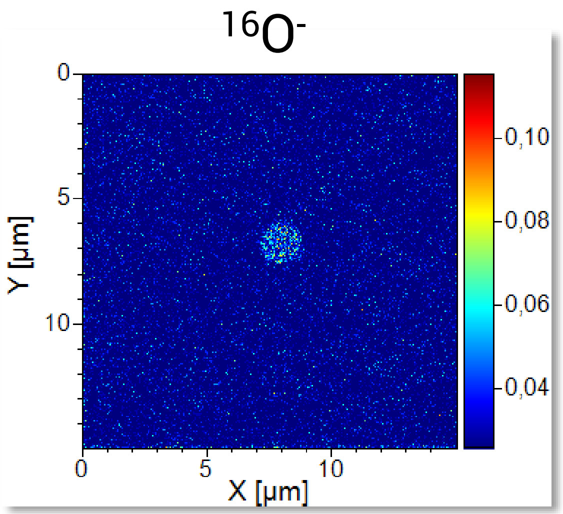
Lateral resolution	< 50 nm (Ga^+) < 60 nm (Xe^+)
Depth resolution	< 3 nm
Detection limit	< 3 ppm (Ga^+) < 1.5 ppm (Xe^+)
Mass resolution	> 800 (> 3500)

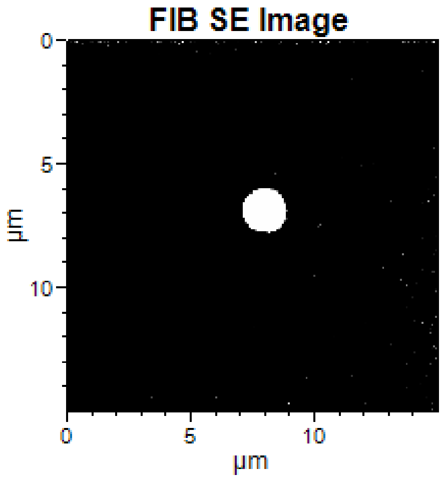
TOF-SIMS

- Micro- and nanoparticles analysis (Si, Al impurity on Si wafer)

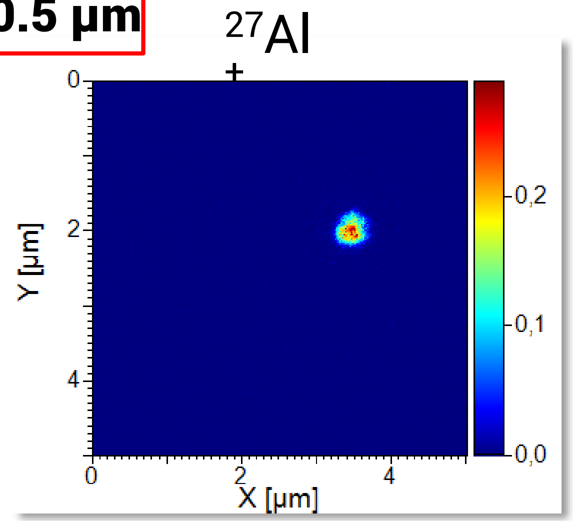
Ø 2 µm

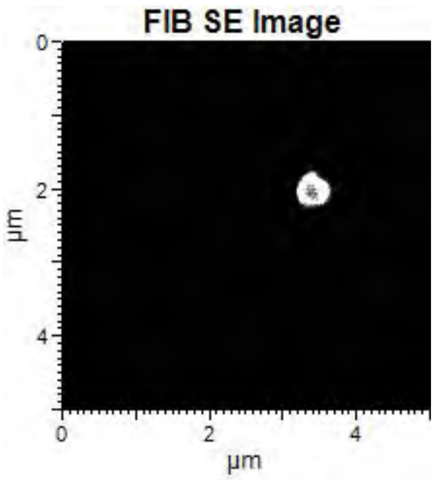




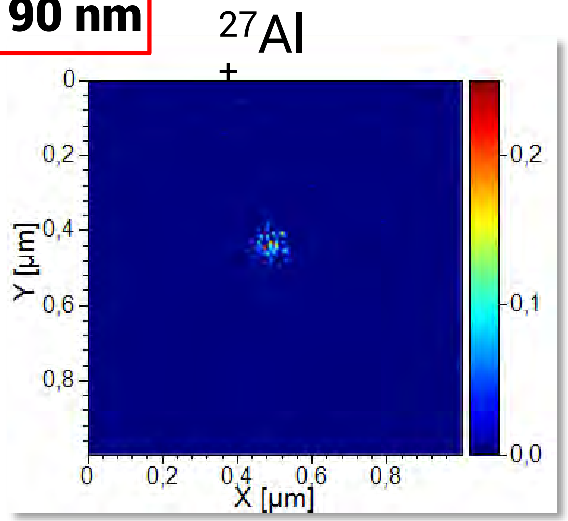


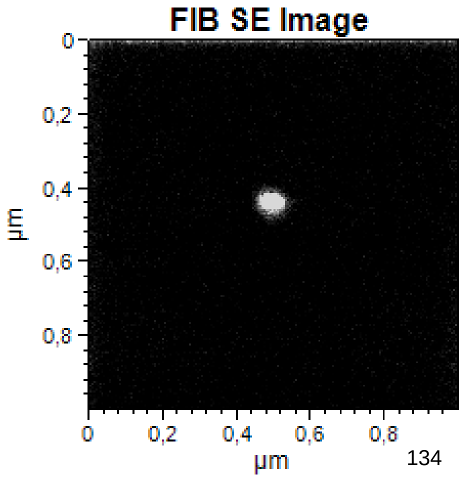
Ø 0.5 µm





Ø 90 nm





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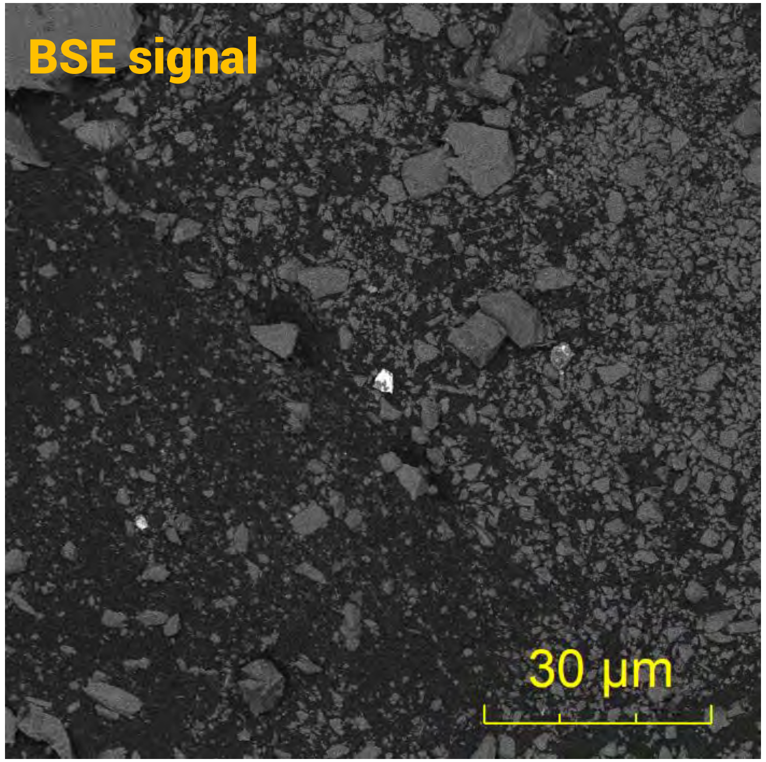
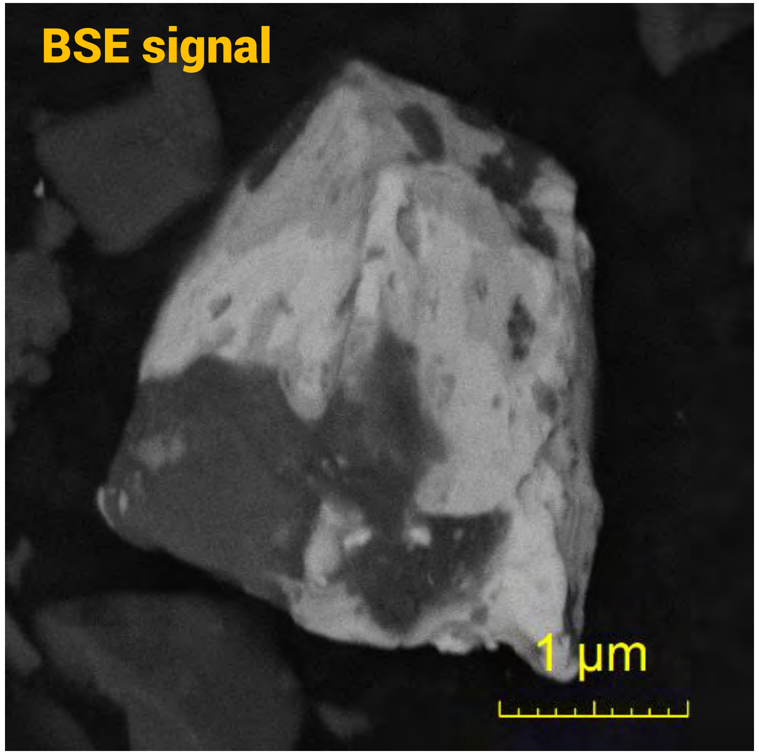
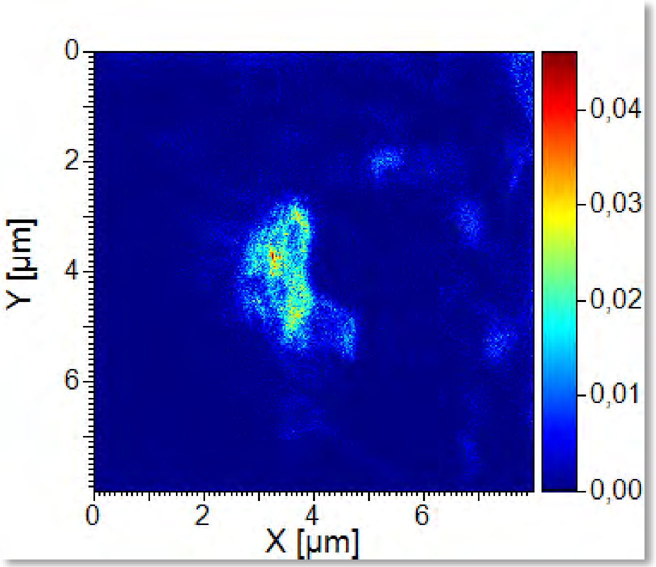
TOF-SIMS

- **Micro- and nanoparticles analysis (U)**

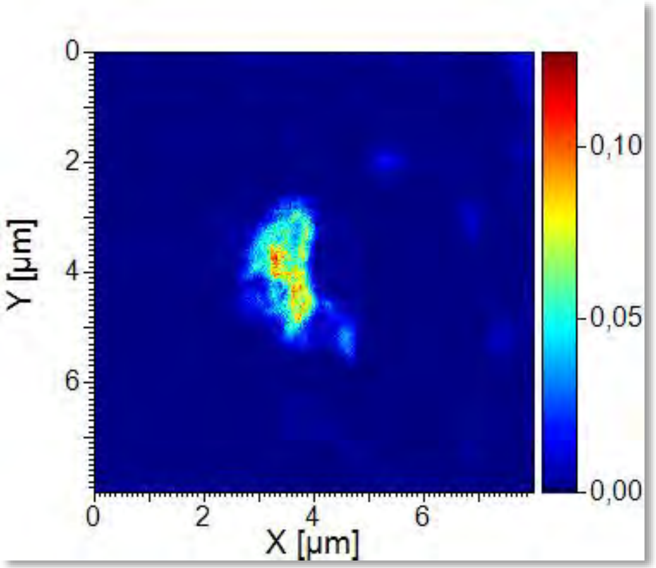




$^{238}U^+$

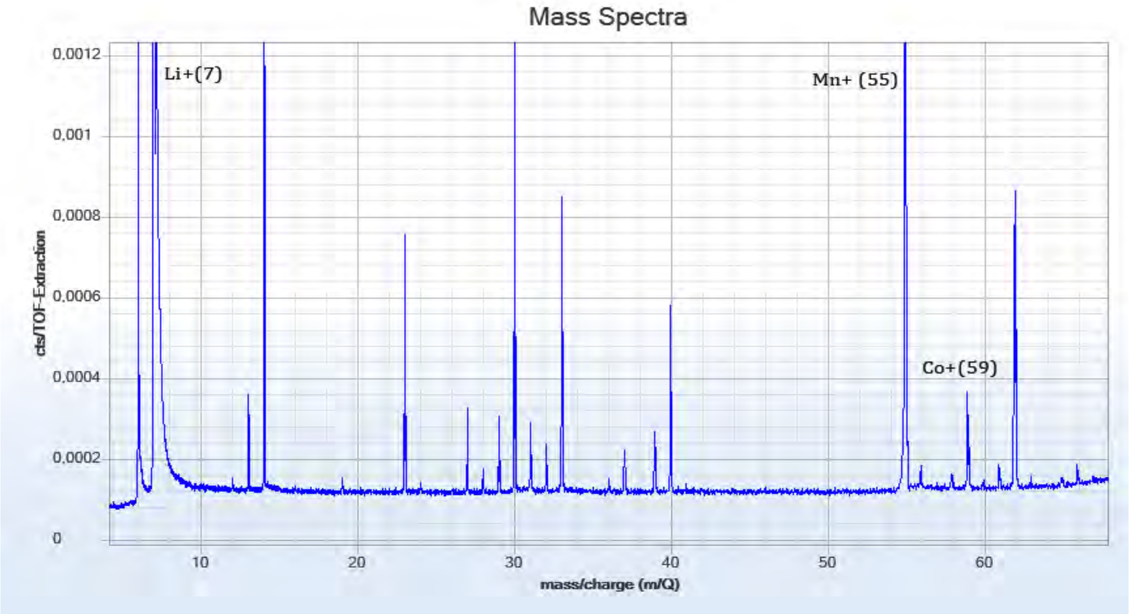


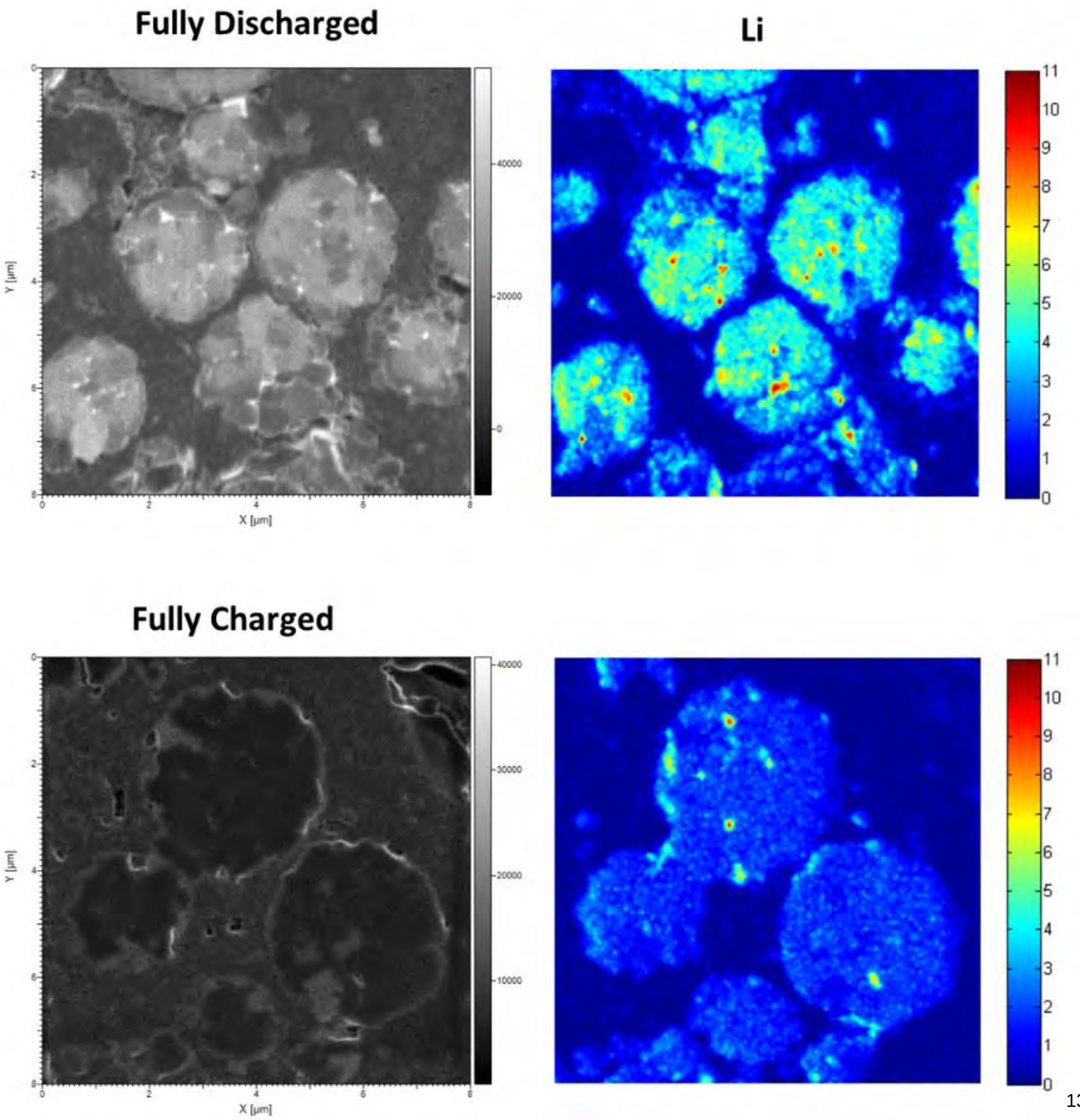
$^{238}U^{16}O^+$



TOF-SIMS

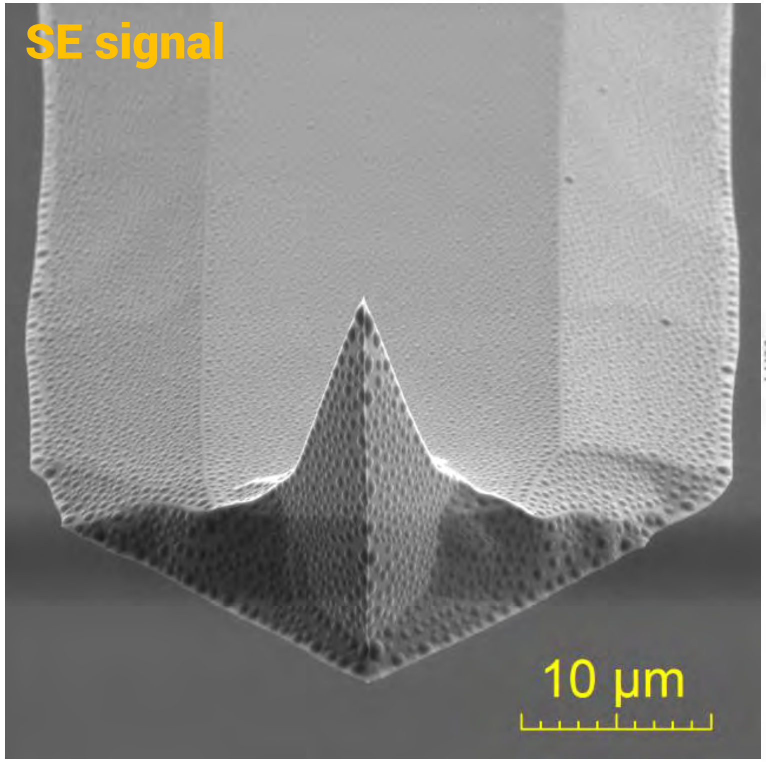
- **Li battery**

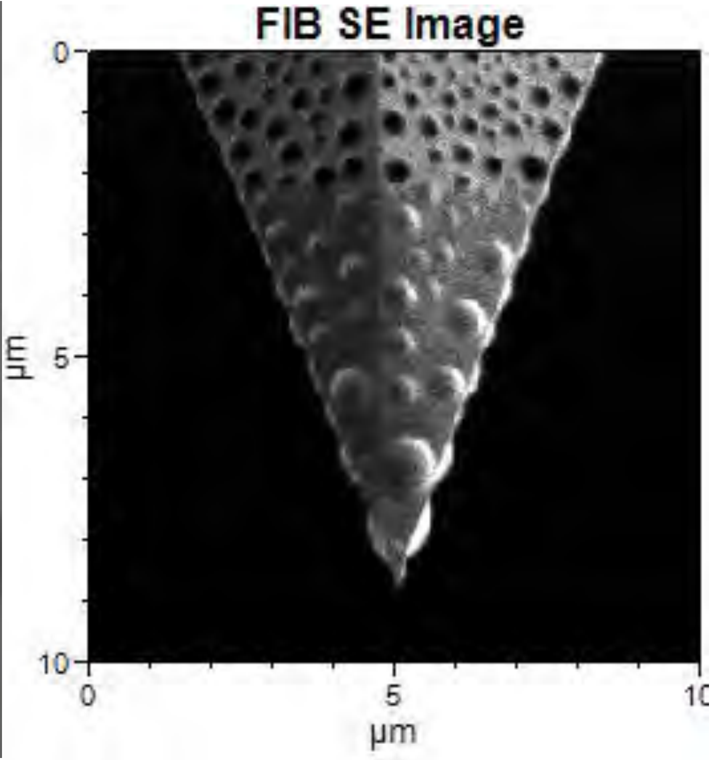




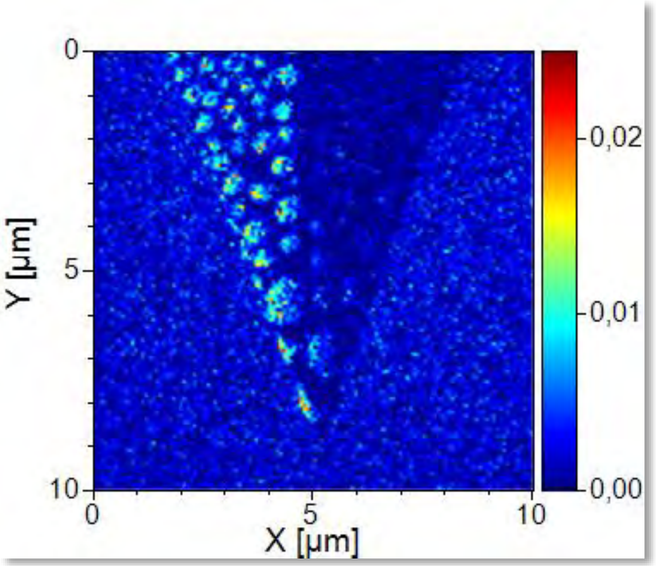
TOF-SIMS

- **Organic contamination on silicon AFM tip**

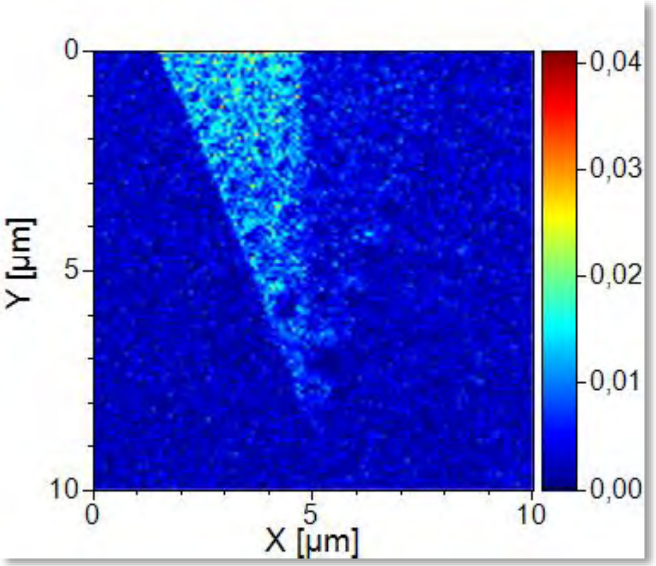




$^{12}C_2^-$

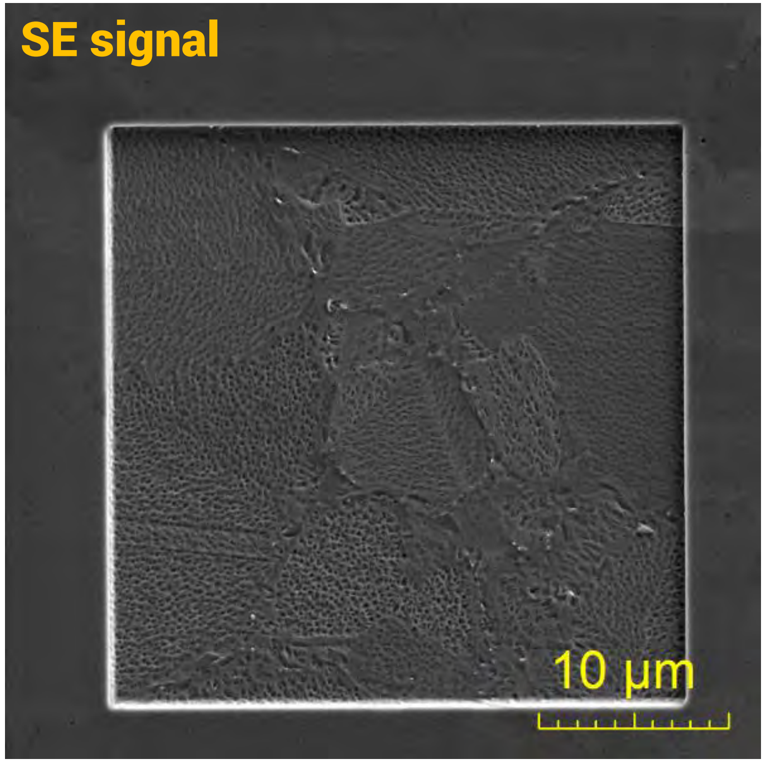


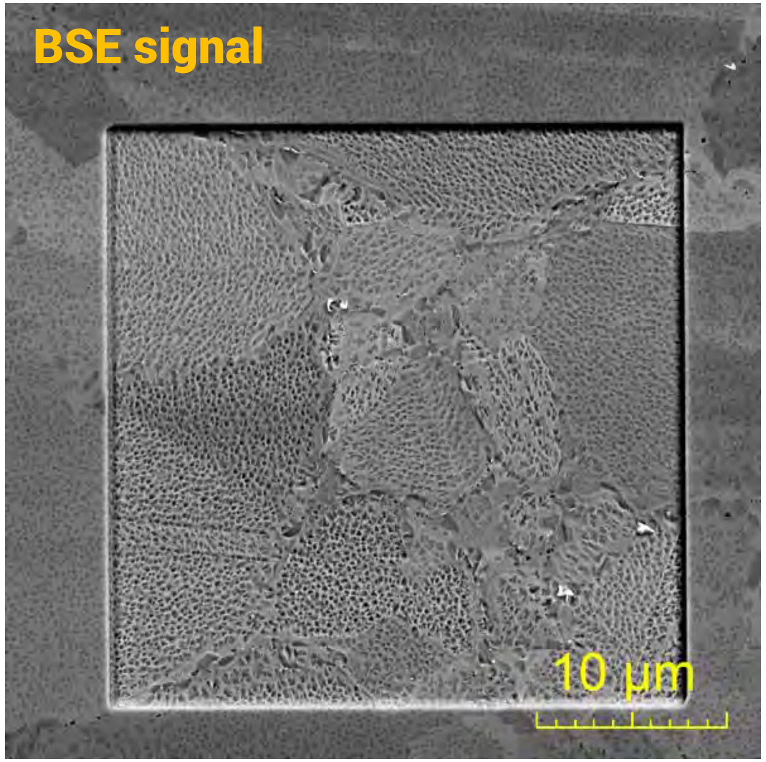
$^{16}O^-$



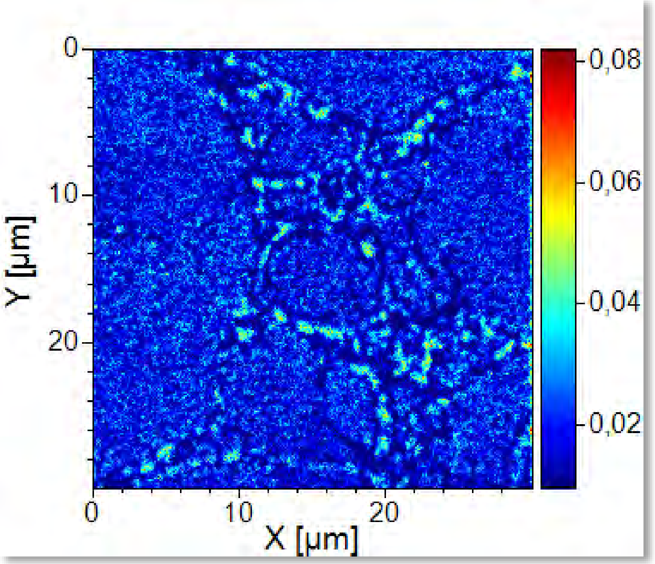
TOF-SIMS

- **Study of metal grain boundaries**

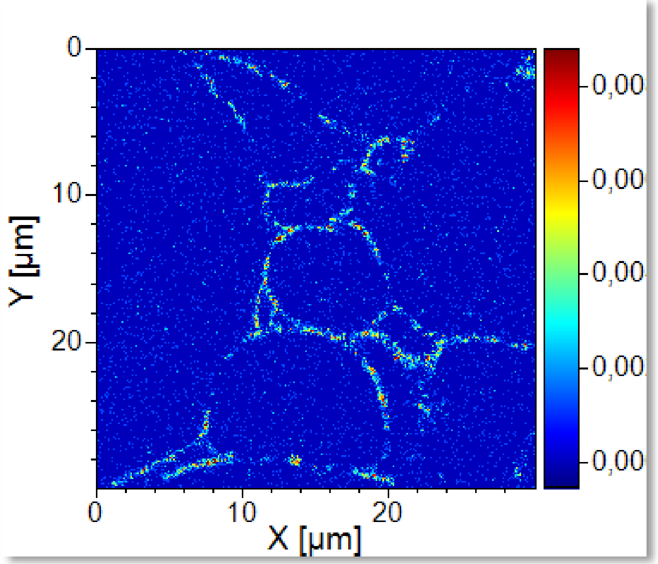




$^{48}Ti^{+}$

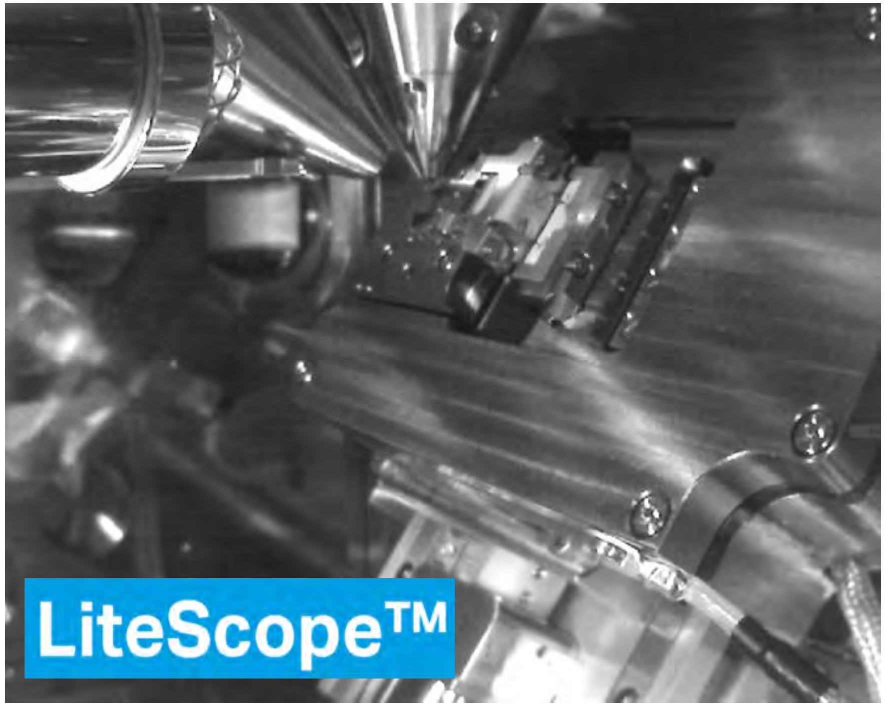


$^{90}Zr^{+}$



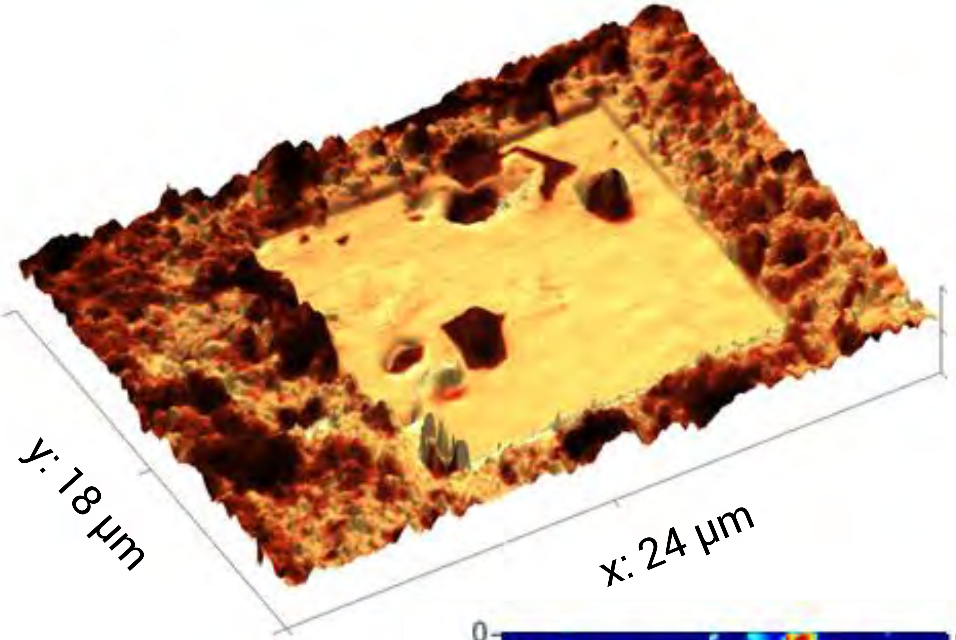
TOF-SIMS

- **Topography measurement by AFM**

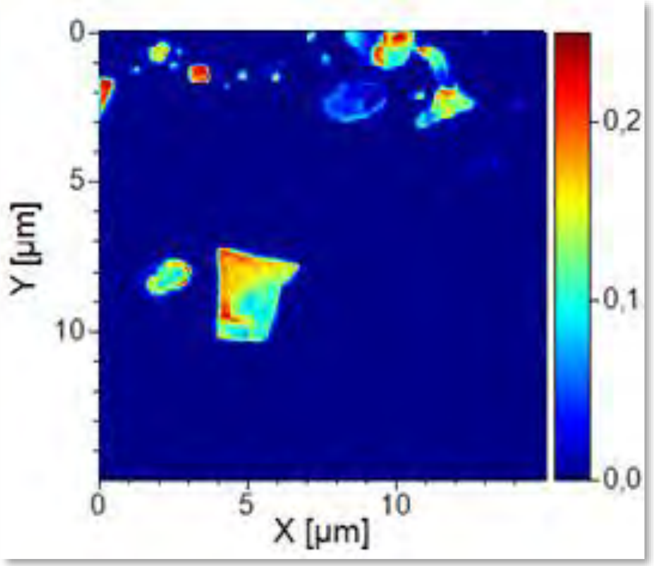


NenoVision

CPEM (Topography + BSE)

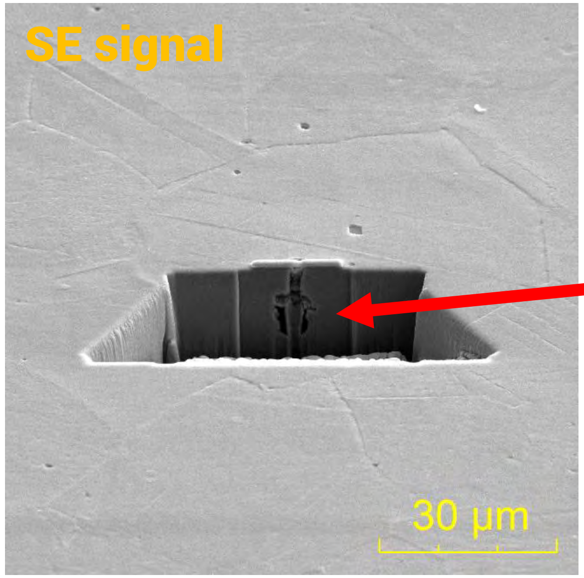


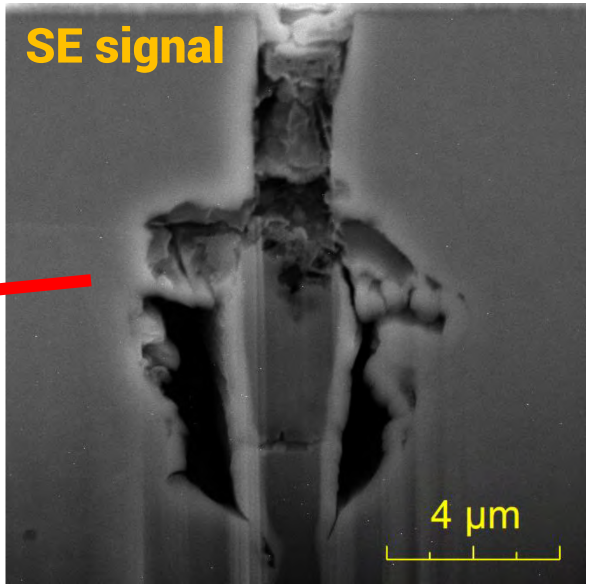
$^{27}Al^{+}$

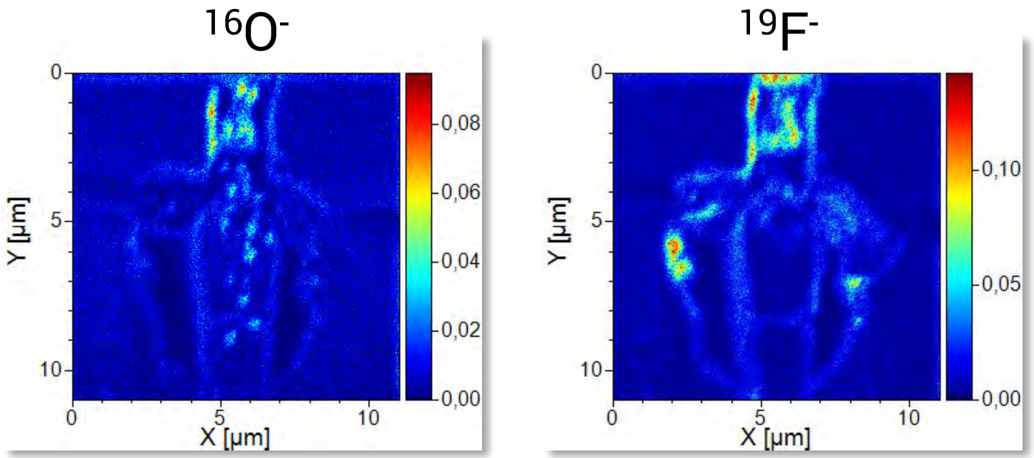


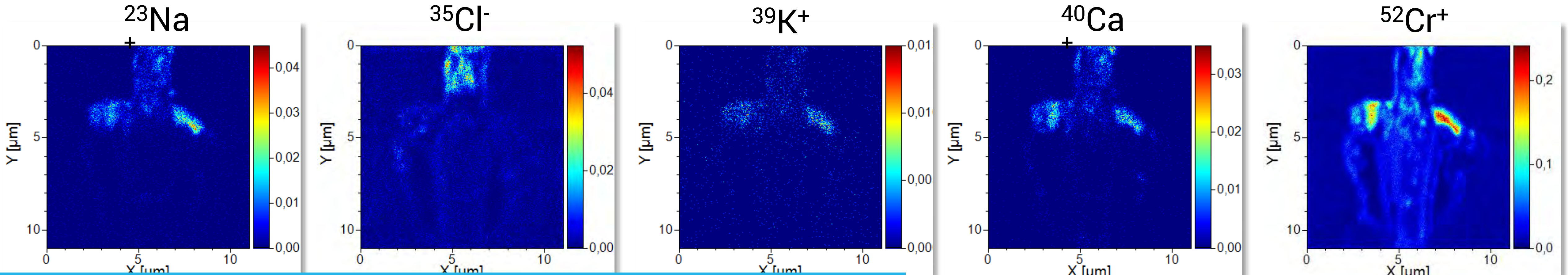
TOF-SIMS

- **Analysis on cross-section (corroded inclusion in metal surface)**





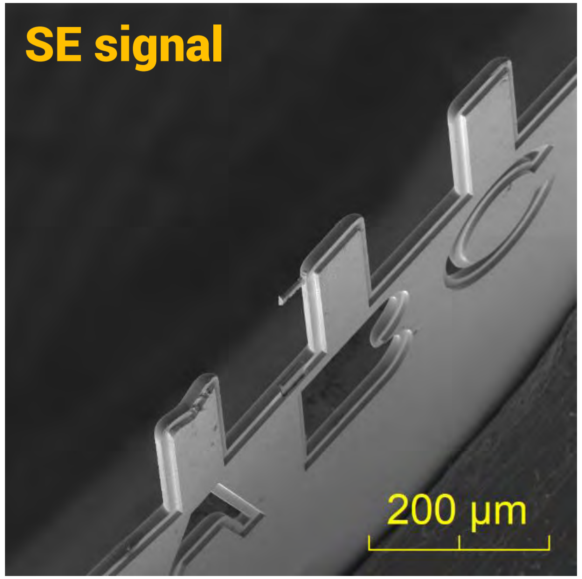


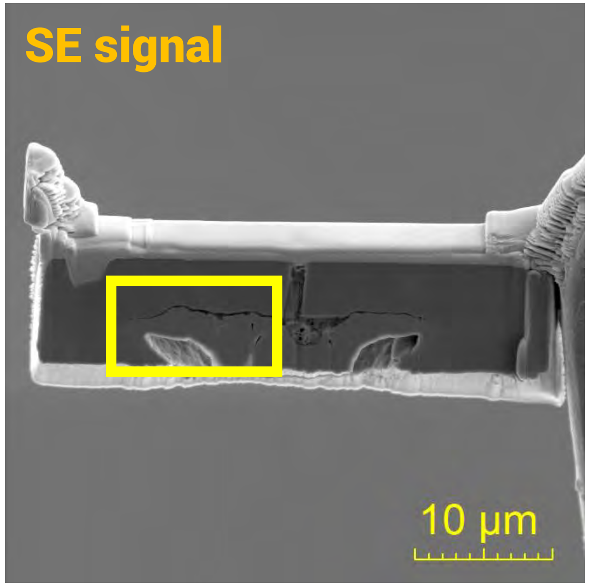


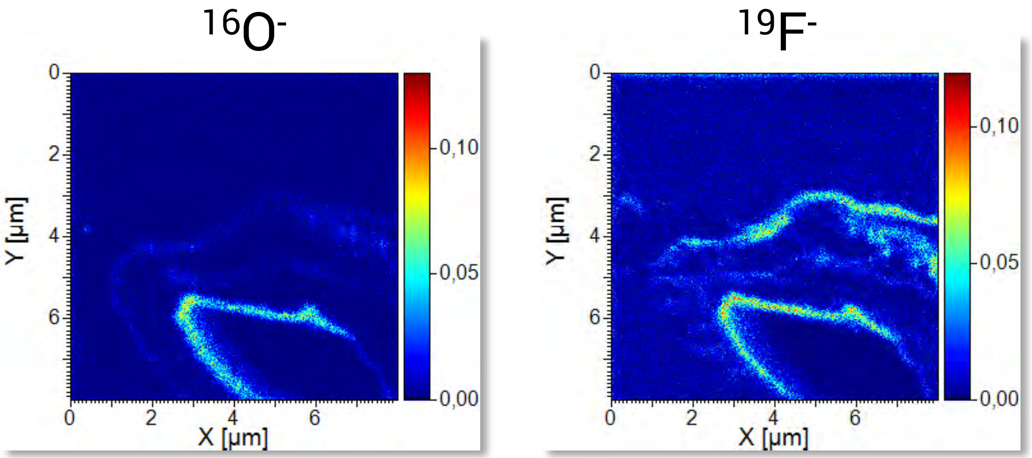
Many thanks to S. Simison, INTEMA CONICET UNMdP, Argentina

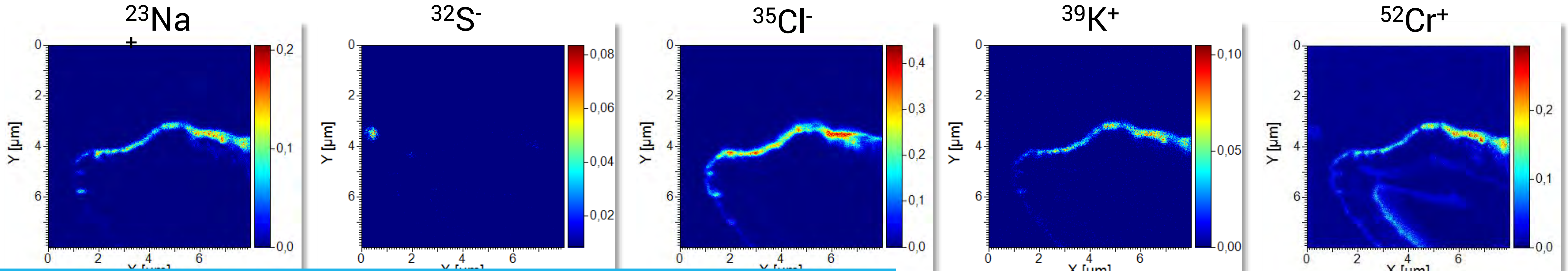
TOF-SIMS

- **Analysis on lamella (corroded inclusion in metal surface)**









Many thanks to S. Simison, INTEMA CONICET UNMdP, Argentina

Thank you for your attention

COMBINED LASER AND PHOTOGRAMMETRIC MEASUREMENT FROM THE AIR AND FROM THE GROUND

Marko Paško [1]
[1] X3D

Abstract

Combined laser and photogrammetric airborne, mobile and terrestrial measuring

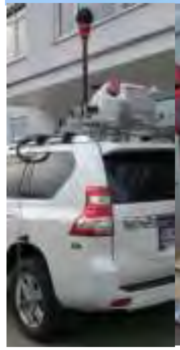
Author: Ing. Marko Paško, Expert_for_3D_Landscape, spol. s r.o., Slovakia, www.x3d.sk

Key words:
- Riegl LMS - airborne, mobile, UAS and terrestrial laser scanning and mapping systems
- Vexcel Imaging - airborne, mobile and terrestrial digital photogrammetry and mapping systems
- 3D mapping and data acquisition
- advantage of combination / data fusion from multiple sources,
- outputs from complex mapping systems,
- detailed high density data
- processing software

In this presentation will be provided answers to questions: - Why to use for 3D data acquisition or mapping the laser and photogrammetric technologies? - Why to combine laser and photogrammetric data acquisition? - Why to combine airborne and mobile data?

We will preview most advanced solutions in laser scanning and digital photogrammetry using examples of the newest products of Riegl Laser Measurement Systems and Vexcel Imaging. As conclusion we summarize most important factors for successfull implementation of 3D mapping solutions in professional work.

Kombinované laserové a fotogrametrické meranie zo vzduchu a zo zeme

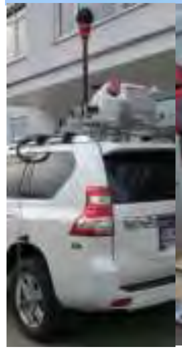


- laserové a fotogrametrické technológie na 3D meranie

  RIEGL Laser Measurement Systems   **VEXCEL** Imaging

- distribútor pre SR: Expert_for_3D_Landscape, spol. s r.o., www.x3d.sk

Témy:




1. Prečo využívať na zber priestorových dát, resp. mapovanie laserové a fotogrametrické technológie
2. Prečo kombinovať laserový a fotogrametrický zber dát
3. Prečo kombinovať dáta zo vzduchu a zo zeme
4. Riešenia Riegl
5. Riešenia Vexcel Imaging
6. Rozhodujúce faktory pre nasadenie v priemyselnej praxi


1. Prečo využívať na zber priestorových dát / mapovanie laserové a fotogrametrické technológie

- obe technológie
    - **vysoký potenciál automatizácie, bezdotykové**
    - **možnosť využitia dynamického snímania s časovou synchronizáciou**
    - **vysoká hustota + presnosť dát**
    - **kalibrovateľné**
- **fotogrametria**
    - tradičná mapovacia metóda dlhodobo, **plošné snímanie s prekrytom**
    - dobrá dostupnosť senzorov / digitálnych kamier, **lacnejšia**
- **laserové skenovanie**
    - novšia mapovacia metóda, **bodové snímanie lúčom s viacnásobným odrazom**
    - **vyššia cena** – rýchly pokrok vo vývoji, **viac robotizácie**

2. Prečo kombinovať laserový a fotogrametrický zber dát

- donedávna - 2D GIS, papierové mapy, digitalizované **staršie kartografické diela**
- bežné sú 3D rastrové dáta DTM/DHM s rastrom 100m, resp. **manuálne vyhodnocované** databázy budov
- dostupné dáta obsahovo nevyhovujú dnešným potrebám - **moderné priemyselné aplikácie** (autonómne dopravné systémy, monitoring kvality líniových stavieb, krízový management, ochrana životného prostredia, poisťovníctvo, kriminalistika) **potrebujú na automatizáciu procesov aktuálne a kvalitné dáta s vysokou hustotou**
- Zber dát má svoju cenu, preto by sa mal vykonávať efektívne:
  - **automatizovane, bezdotykovo** (jeden operátor namiesto stoviek meračov)
  - v krátkom čase, **najlepšie dynamicky** (skrátenie trvania zberu dát)
  - s **vysokou hustotou + naraz viac senzorov / doplňujúcich sa technológií**
  - **s vysokou presnosťou, homogénne na kalibrovaných meracích systémoch**

3. Prečo kombinovať dáta zo vzduchu a zo zeme

- Kvôli potrebe viditeľnosti objektov z rôznych strán (z hora, zo zeme, znútra)
- Vzájomne prevrátená hierarchia medzi počtom daných typov nosičov a množstvom zameranej plochy:

špecializovaný merací nosič	**zamerané plocha**
Lietadlá: **málo** vhodných meracích lietadiel	celoštátne, celé kraje, celé okresy, **veľkoplošný zber**
Autá: meracie vozidlá **pomaly pribúdajú**, bude	celé kraje, celé okresy, celé mestá, **líniový zber**
v budúcnosti každé auto bude meracie vozidlo?	
UAS: **rýchlo pribúda** počet meracích dronov	menšie mestá, lokality, **lokálny plošný aj líniový zber**
Človek: **teoreticky každý**, keď fotí, zbiera dáta	bodový **zber dát, menšia plocha vysoko detailne**

- **Dôležité pre analýzu chýb a automatizáciu:**
  - **redundantnosť dát**
  - **treba kombinovať 2 vzájomne nezávislé metódy**

4. Riešenia RIEGL Laser Measurement Systems

Všestranné riešenia:

*** Terestrické:**

- **[VZ-400i](#)** ... dosah 800m, presnosť 5mm, georeferencovanie v reálnom čase, cloud
- **[VZ-2000i](#)** ... dosah 2000m, presnosť 10mm

*** Mobilné:**

- **[VMX(450)-1HA](#)** ... mobilné presné skenovanie,
- **[VMQ-1HA](#)** ... light-verzia s 1 skenovacou hlavou

<- už aj v SR

*** Letecké + UAV:**

- **[VUX-1](#)** ... 3 rôzne hlavy + **[RiCopter](#)** / **[VP1](#)**
- **[VQ-880-G, -GH](#)** ... topo-hydro mapovanie
- **[VQ 1560i](#)** ... city mapping, veľkoplošné mapovanie, duálny skener

RIEGL LMS-Q1560

5. Riešenia Vexcel Imaging

- fotogrametrické technológie na 3D mapovanie - dôraz na fotogrametriu
- **Letecké riešenia:** – letecký zber dát špecializovaným meracím lietadlom
  - Flexibilné – vymeniteľné objektívy UC Eagle Mark 3, **najväčšia šírka záberu 26460 px**
  - Šikmé snímkovanie – UC Osprey Mark 3 Premium
  - Konkurencia satelitným senzorom – UC Condor Mark1 – **38000px**
- **Mobilné riešenia:**
  - UltraCam Mustang – mobilný zber dát autom
- **Pochôdzne riešenia:**
  - UltraCam Panther – zber dát pešo človekom
- Jedno softvérové prostredie UltraMap – softvér na kompletné automatizované spracovanie zo všetkých druhov senzorov UltraCam

VEXCEL IMAGING

Minulý rok prezentované mobilné riešenie:
UltraCam Mustang

na pozemný mobilný zber

georeferencovaných obrazových dát

UC Mustang

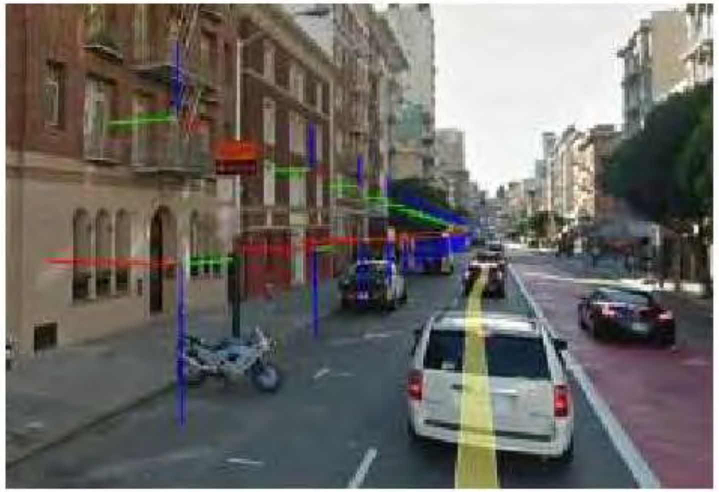
- na **pozemný mobilný zber** georeferencovaných obrazových dát
- Max. **rýchlosť zberu až 120 km/h**
- **Panoramatické zábery 360° vo vysokom rozlíšení**
- **Presné vzájomné nadväzovanie** vďaka LiDARovým dátam
- **Presná poloha a náklony** vďaka integrovanému GNSS/IMU
- **Kompletne kalibrované**
- **Osvedčené a spoľahlivé riešenie** – už nazbieralo viac ako 5 miliónov km
- **Jednoduchý postprocessing v softvéri UltraMap** Terrestrial Essential

výstupy z UC Mustang

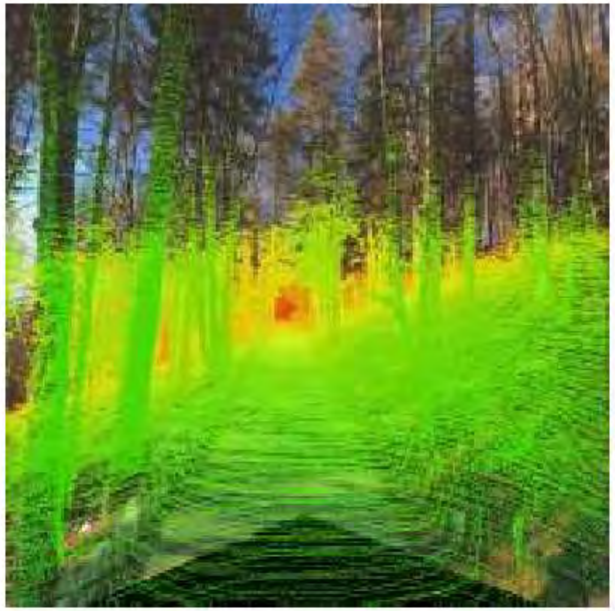
- Georeferencované **panoramatické snímky**
- Georeferencované **mračná bodov**
- Georeferencovaná **trajektória**
- **Kalibračné parametre**
- **Presnosť po postprocesingu +- 2cm**
- Hustota obrazových dát **8 snímok za sekundu z 9 kamier, spolu 54 Mpix**
- Hustota laserových dát **700000 bodov za sekundu** zosynchronizovaných s obrazovými dátami

Dokonalé snímkové panorámy s vysokým rozlíšením, exportovateľné aj pre cave

VEXCEL
IMAGING



Možnosť priameho 3D merania na presne georeferencovaných dátach



Konferencia 3D meranie a zobrazenie, Bratislava, 21.-22.9.2017

Ing. Marko Paško, Expert_for_3D_Landscape, spol. s r.o.

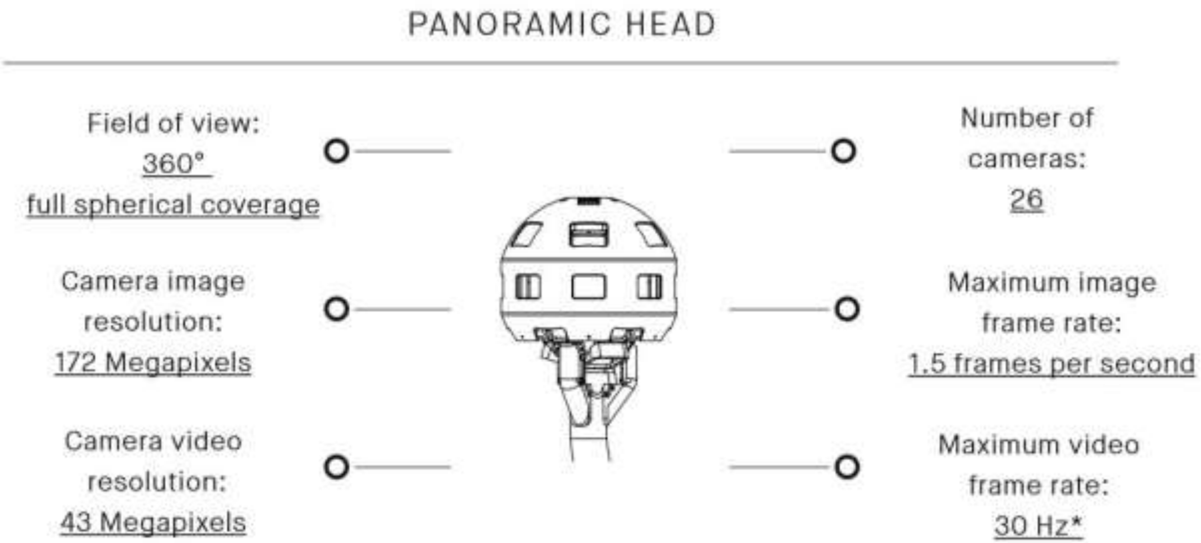
EXPERT FOR 3D LANDSCAPE

VEXCEL
IMAGING

Novinka - pochôdzne riešenie:
[UltraCam Panther]

na pozemný zber

georeferencovaných obrazových dát



Príklad: ideálna kombinácia - spoločné využívanie zdrojových zariadení v lietadlách

- Riegl LMS Q1560i + Vexcel UltraCam Eagle Mark 3
- **šetrí peniaze – časť technológií spoločne zdielaná**

6. Zhrnutie – rozhodujúce faktory pre úspešné nasadenie riešení v priemyselnej praxi

- Vyzretosť riešení – **skúsenosti založené na dlhodobom vývoji** HW a SW
- Možnosť prepojenia s inými komplementárnymi štandardizovanými senzormi
- Vysoká **automatizácia** procesov + naviac kvalitné **analytické nástroje** (one-click ale aj manuálne)
- **všestrannosť** technológie schopná spracovať v jednej technologickej linke dáta získané všetkymi 3 zdrojmi – letecky, autom a aj peši

To všetko spĺňajú riešenia RIEGL LMS a VEXCEL Imaging.

Ďakujem za pozornosť. Viac na **www.x3d.sk**

CHALLENGES IN 3D SCANNING

Ján Žižka[1]
[1] CEO, Photoneo - Focused on 3D

Abstract
The ability to accurately localize objects in an observed scene in 3D is critical precondition for many practical applications including automatic manufacturing, quality assurance, or human-robot interaction. We discuss why localization in 3D is hard and show several real-life examples.

Photoneo

Why localization in 3D is hard

Jan Zizka, CEO

Photoneo - Intro

- Slovak based company
- 4 years old
- Manufacturing 3D Scanners
- Developing 3D Camera
- 3D processing software
- Focus on automation

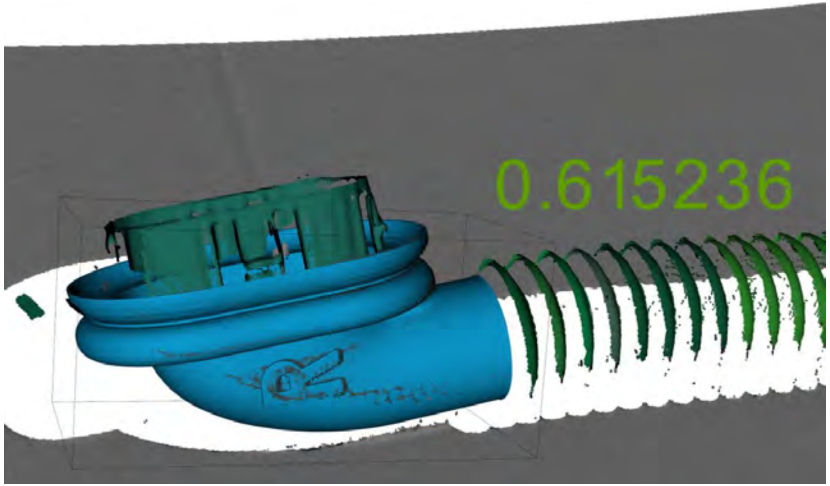
Our team: 46 people

Jan	Tomas	Michal	Brano
			
CEO	CTO	COO	Business Director
PhD in Machine Vision	Computer Vision guru	PhD in AI/Machine Learning	Six Sigma Black Belt & Sales master

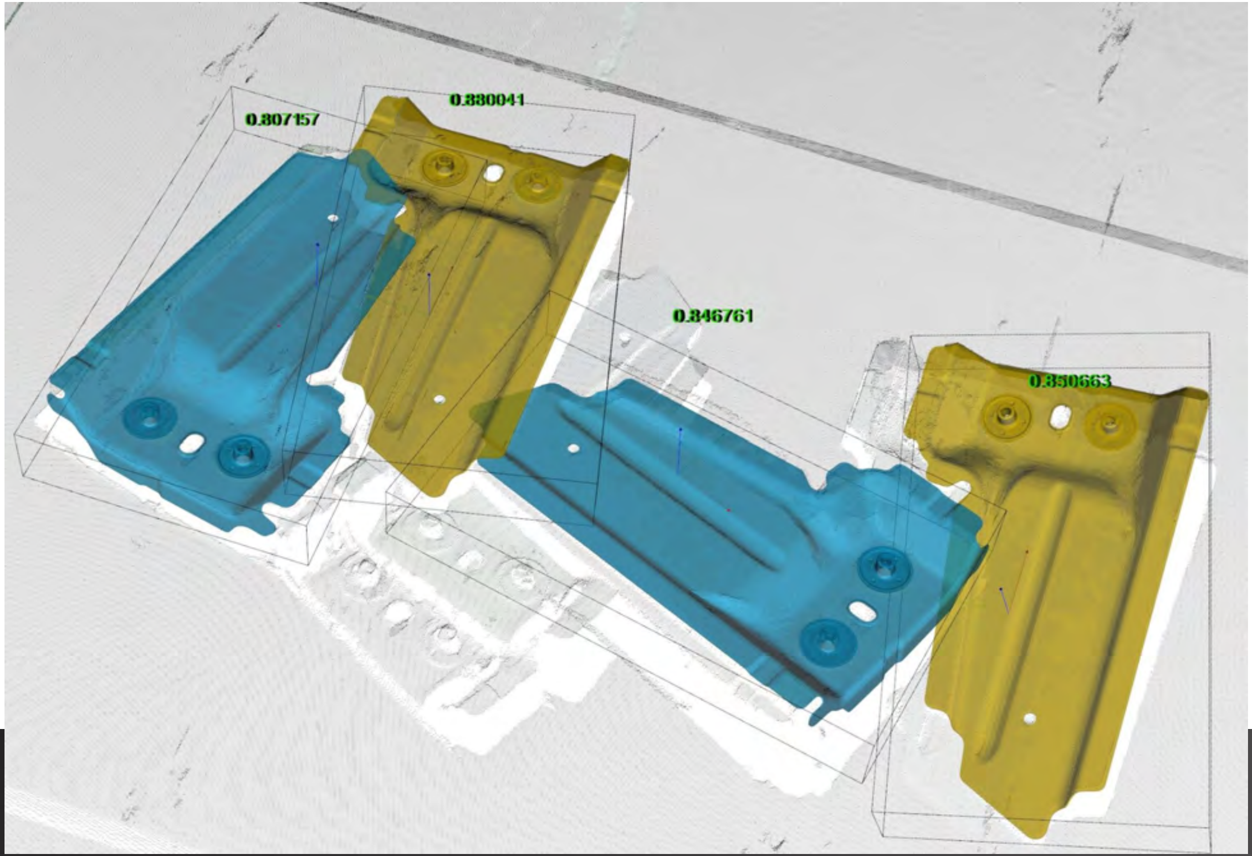

URBAN
SPIRIT

Localization - definition

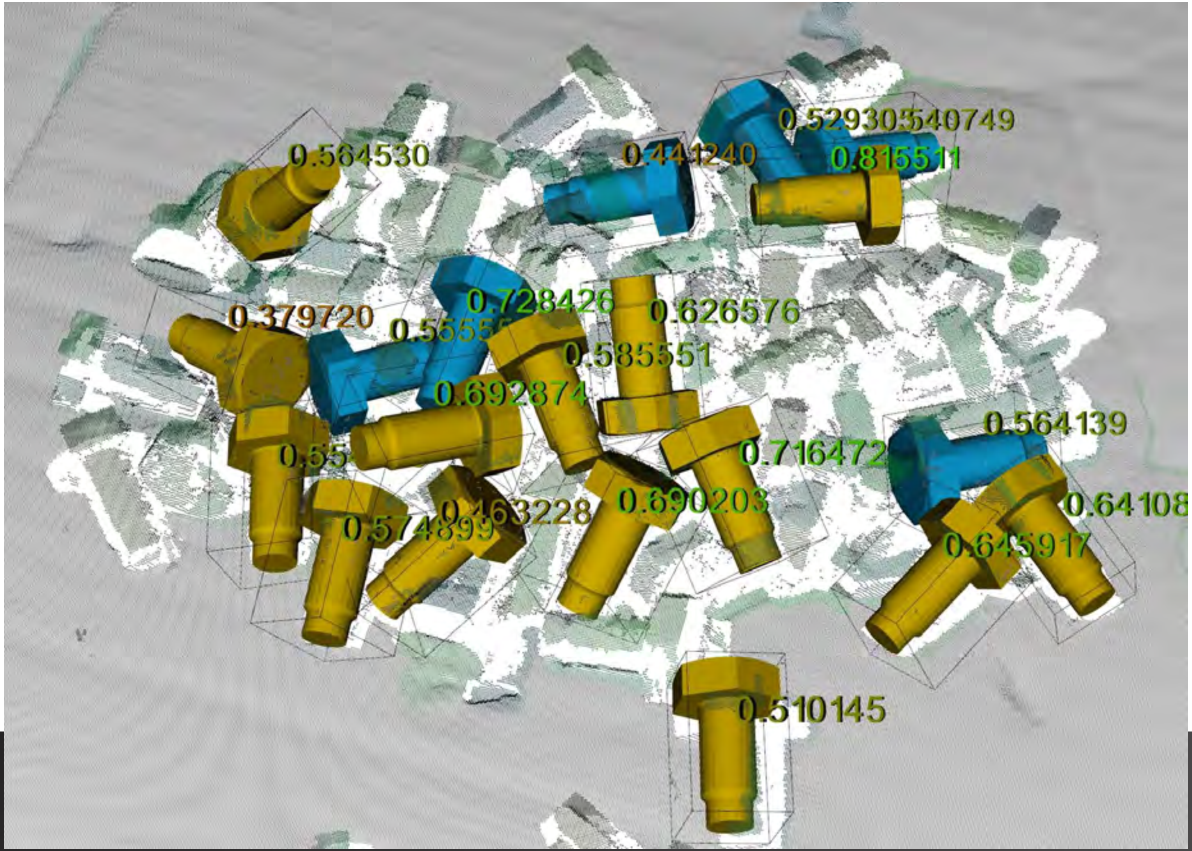
- Input
  - Pointcloud
  - CAD model of the part
    - Or 3D scan
- Task
  - Exact location & orientation of the object
  - Rigid vs Non-rigid



Examples - metal sheets



Examples - screws



Applications

Bin Picking

- Randomly placed & crowded
- Occlusions
- Collision detection

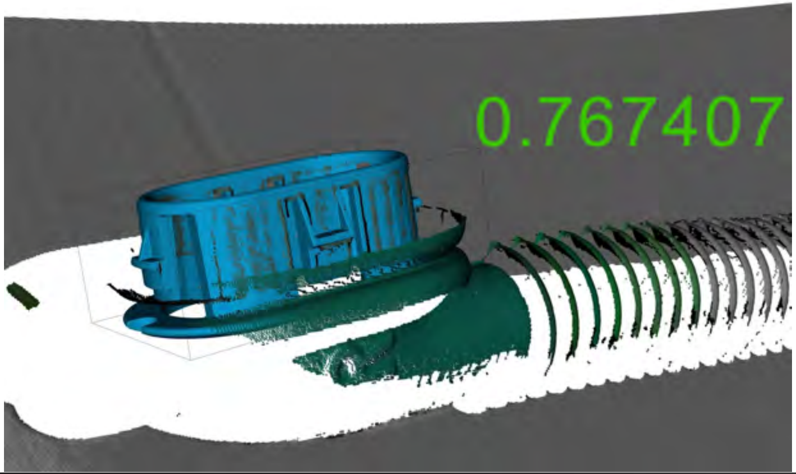
- Gripper design
- Robot path planning

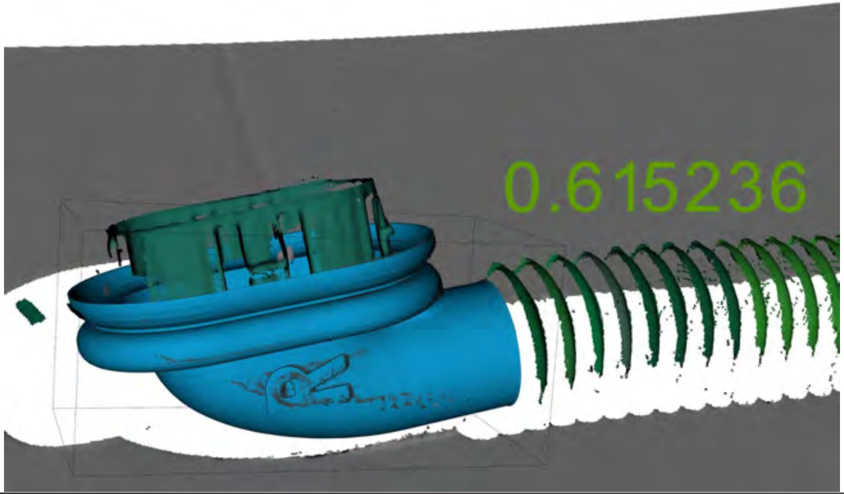

riešenie pre

Alignment / Relative position

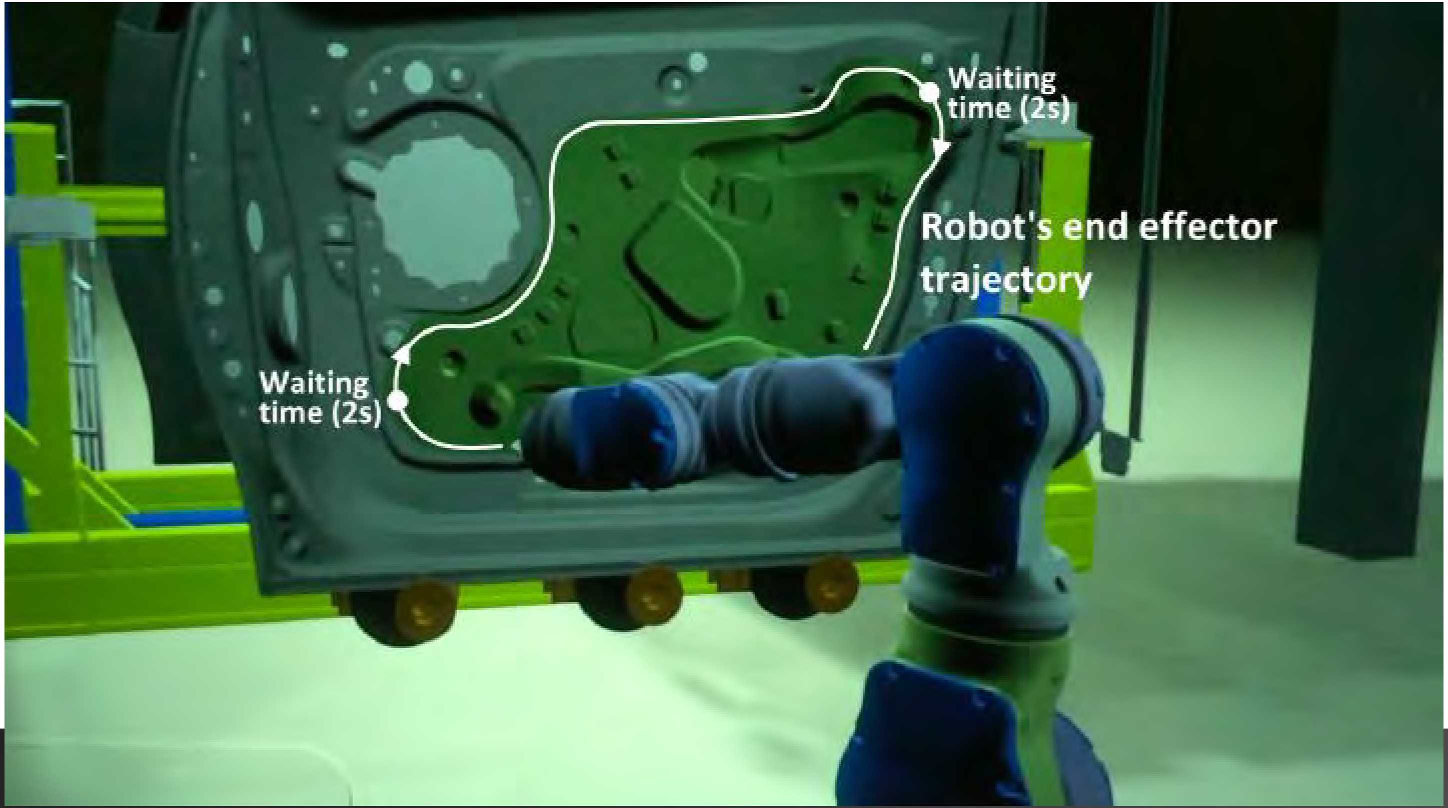
Alignment / Relative position

- Locate A
- Locate B
- Check relative position & orientation

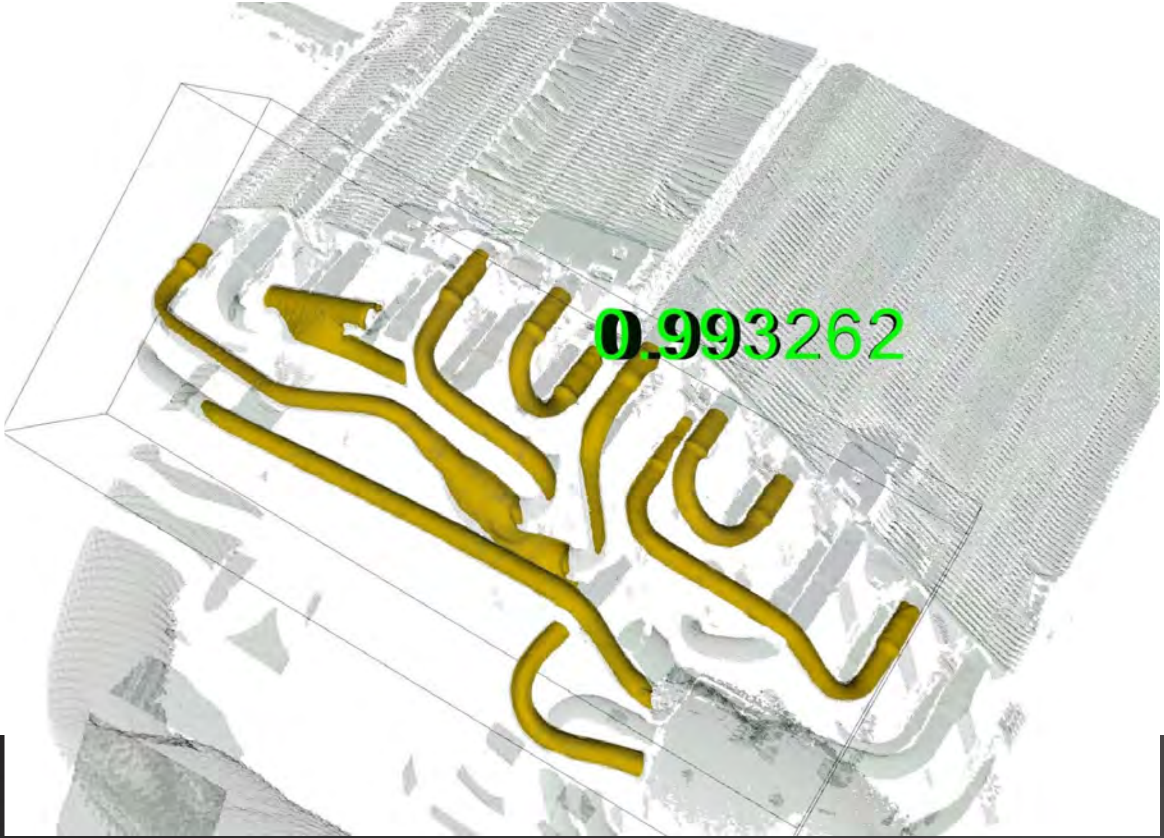




Robot Path Correction

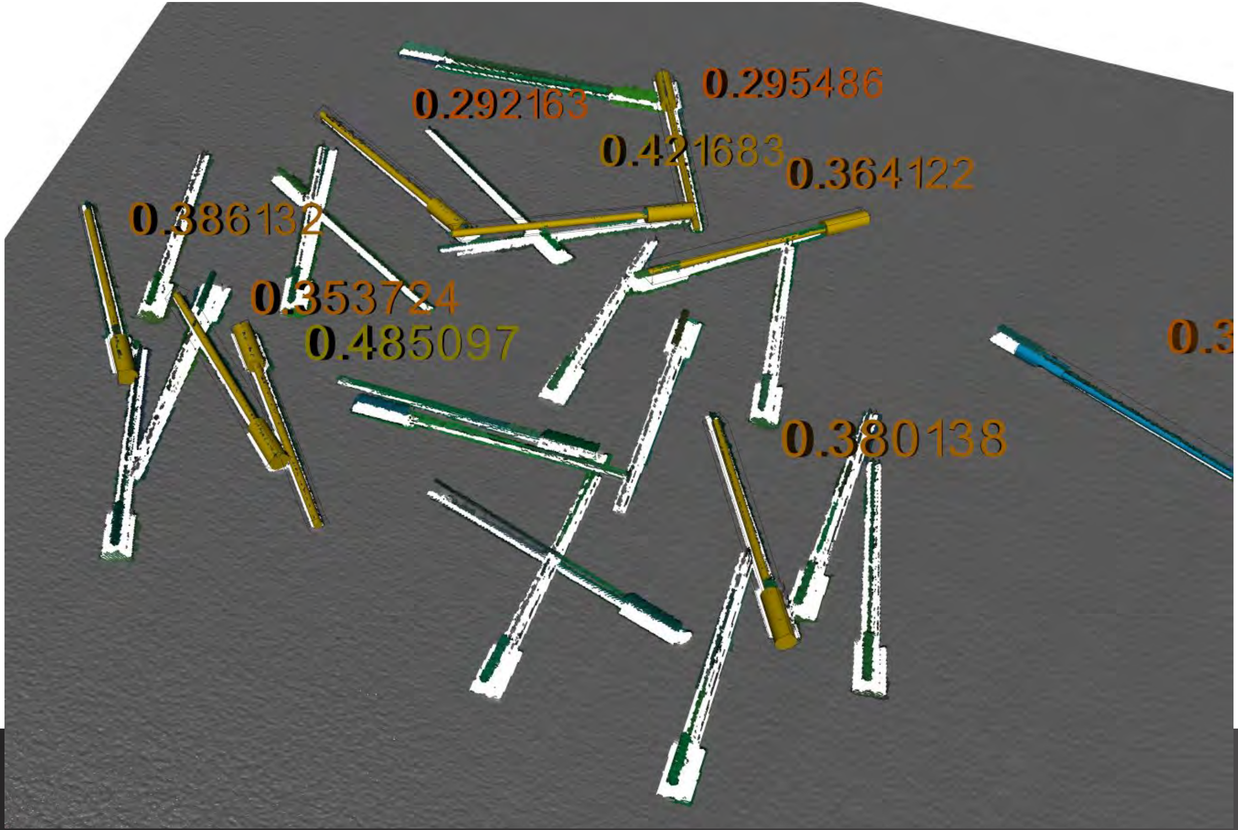


Robot Path Correction - Example

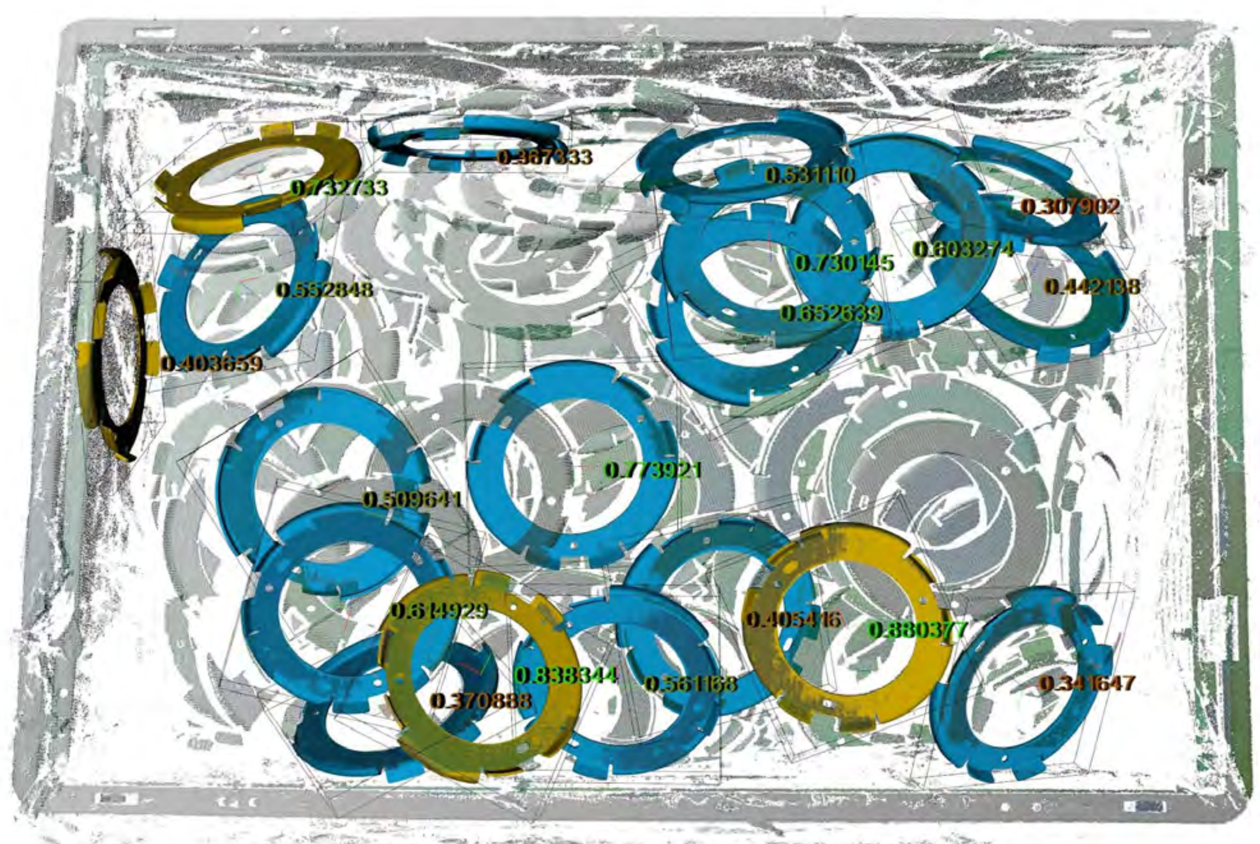


More applications

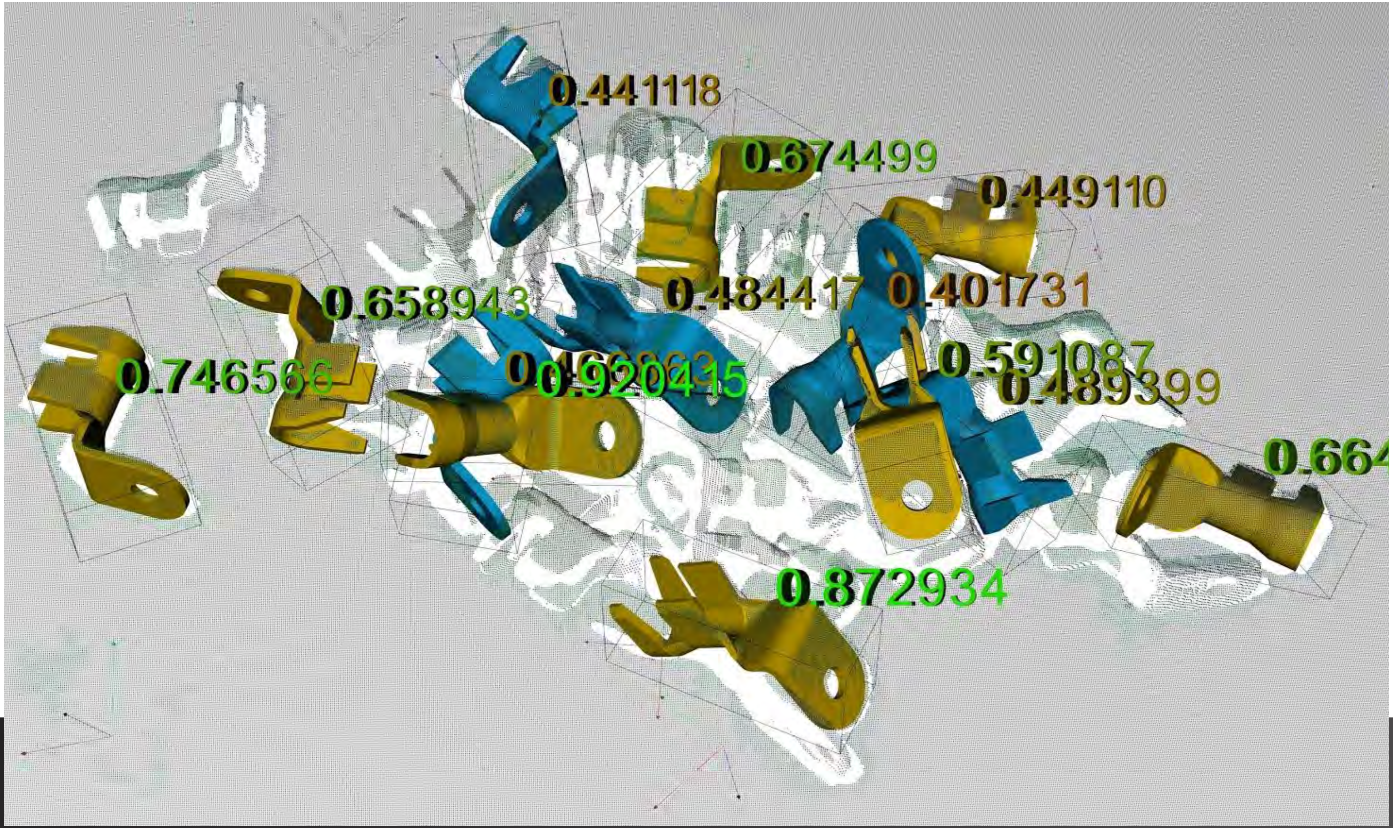
Examples - needles



Examples

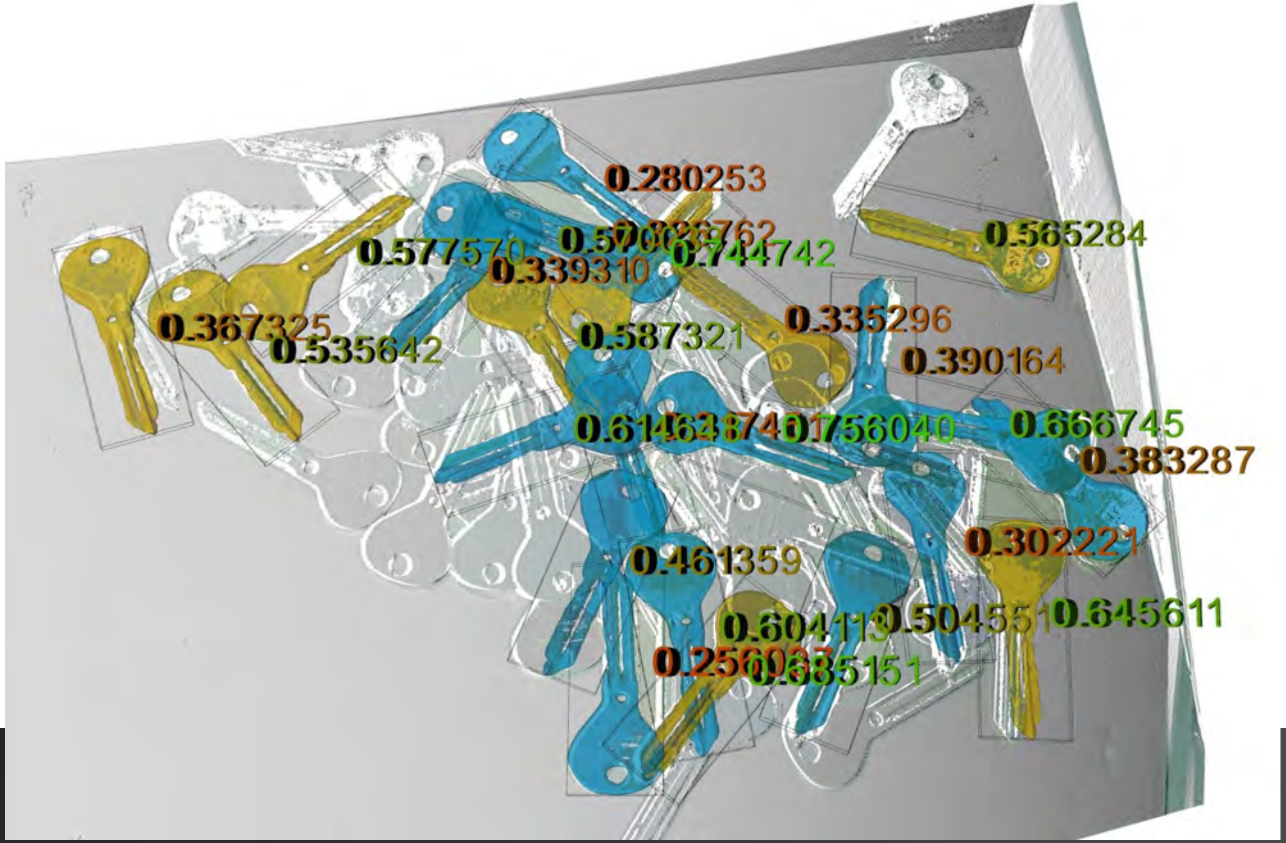

0.367333
0.732733
0.531110
0.307902
0.603274
0.730145
0.442138
0.552848
0.652639
0.403659
0.773921
0.509641
0.614929
0.405416
0.880377
0.838344
0.561168
0.370888
0.341647

Examples



0.441118
0.674499
0.449110
0.658943
0.484417
0.401731
0.746566
0.920415
0.591087
0.489399
0.872934

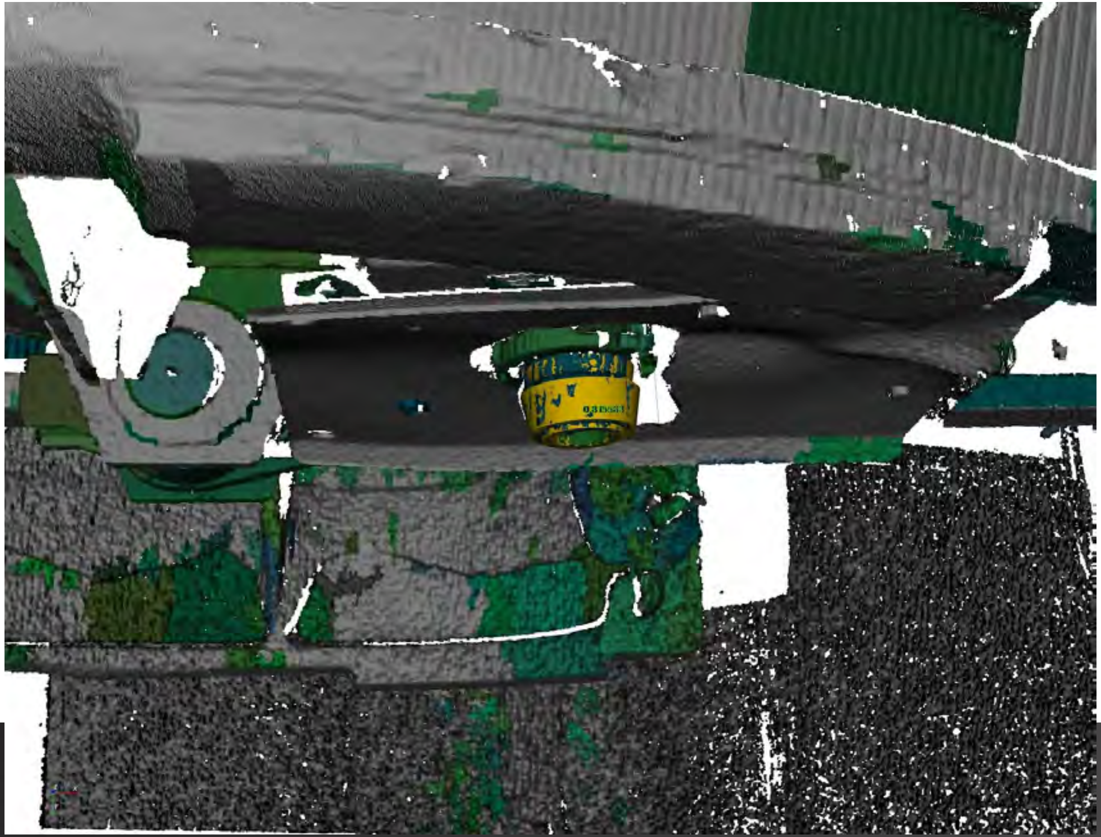
Examples



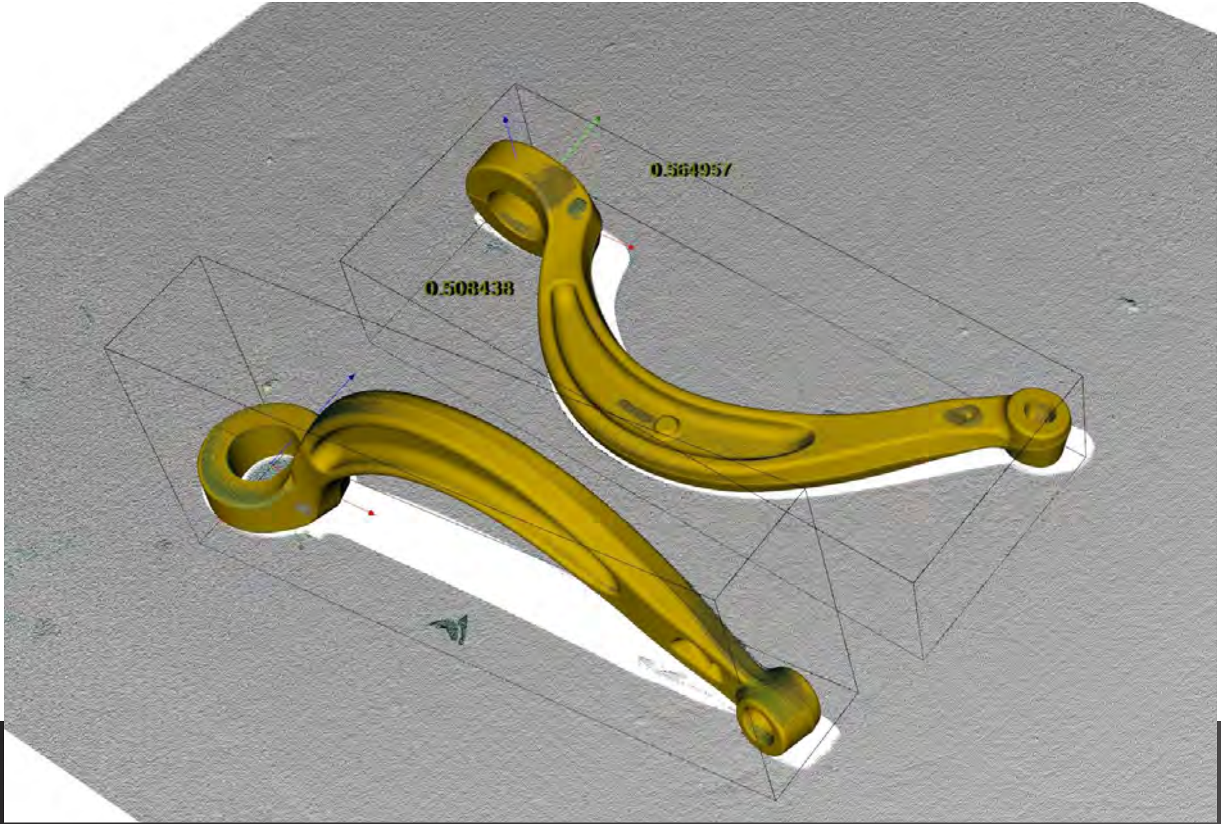
0.280253
0.565284
0.577570
0.744742
0.339310
0.367325
0.535642
0.587321
0.335296
0.390164
0.756040
0.666745
0.383287
0.302221
0.461359
0.645611

Examples

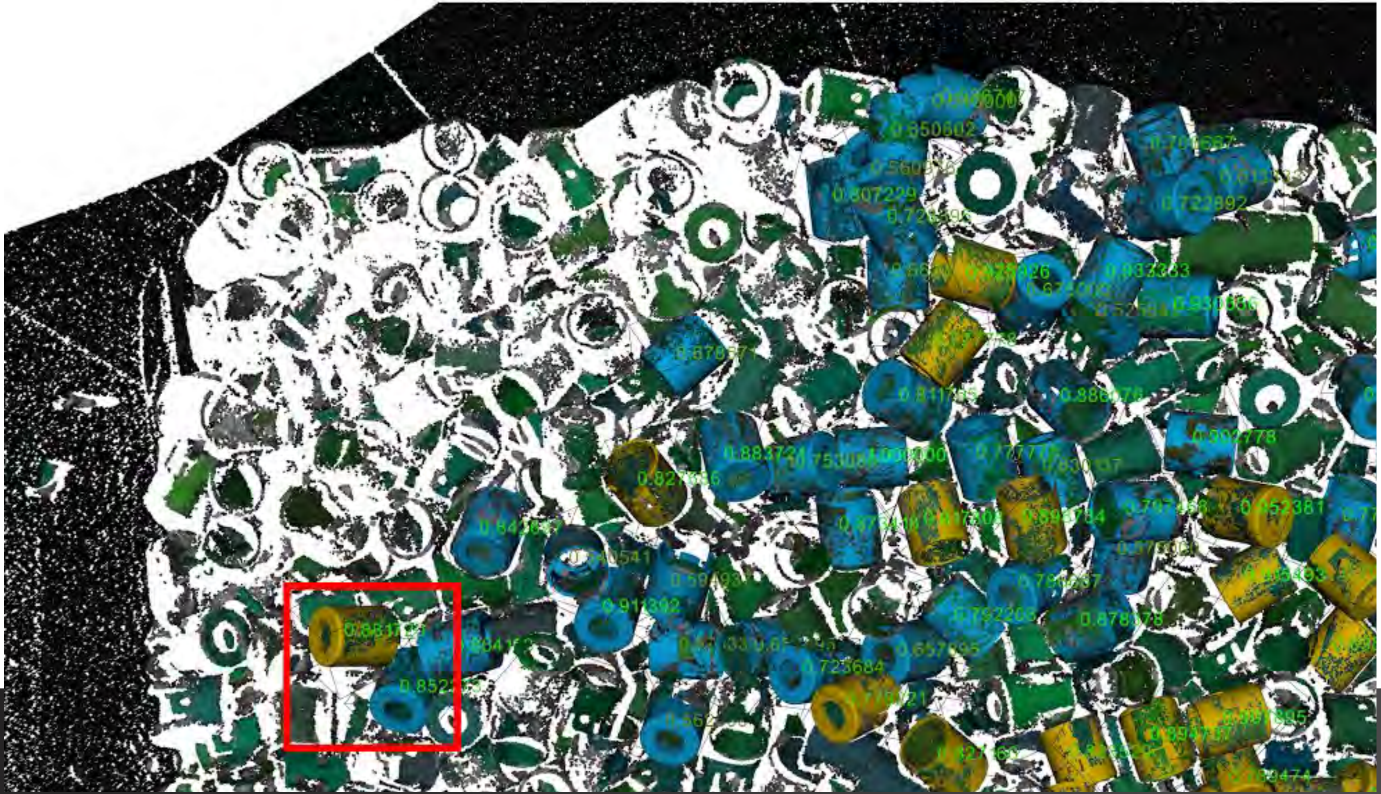
Examples



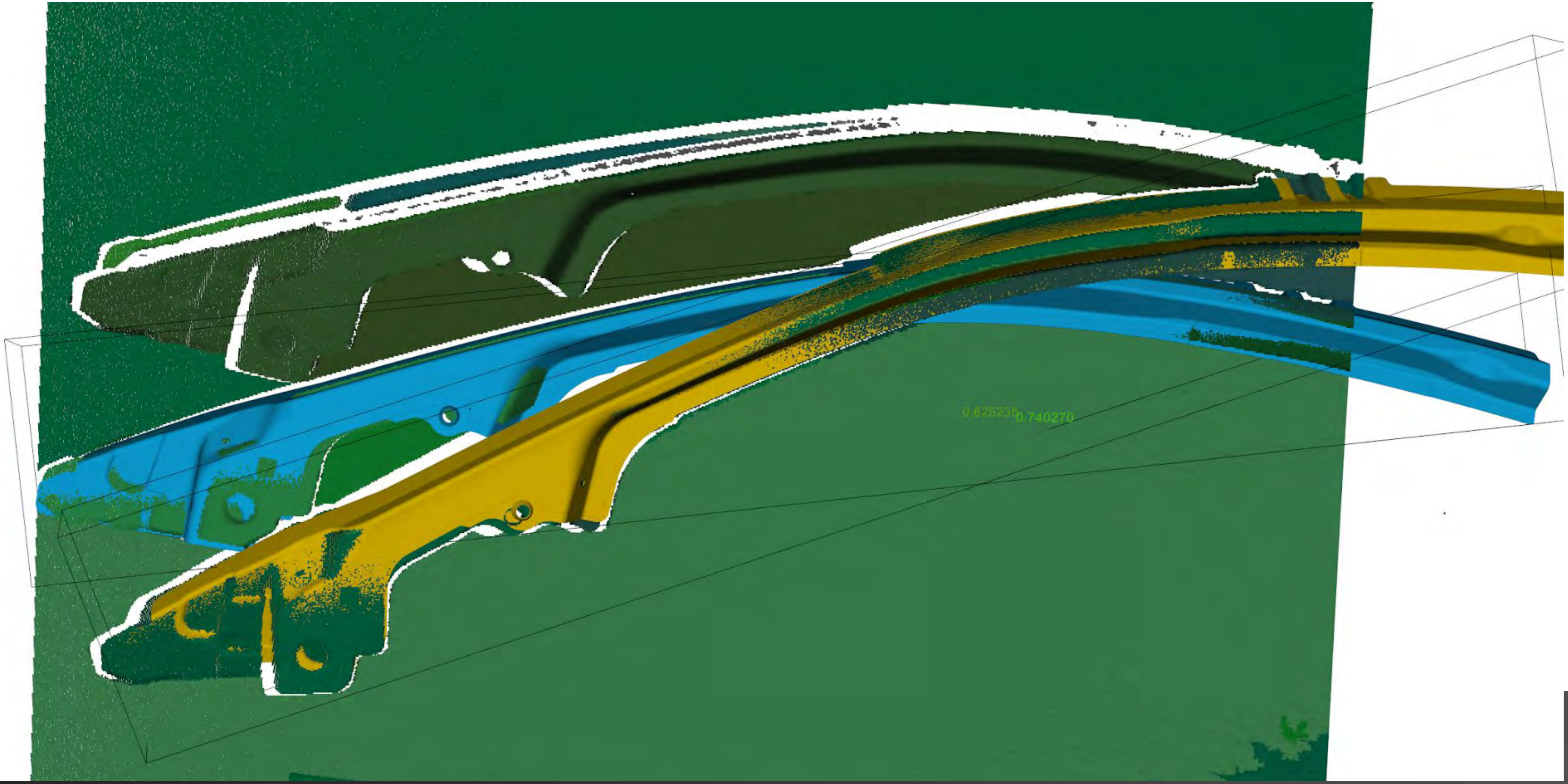
Examples



Limitations - Scan quality



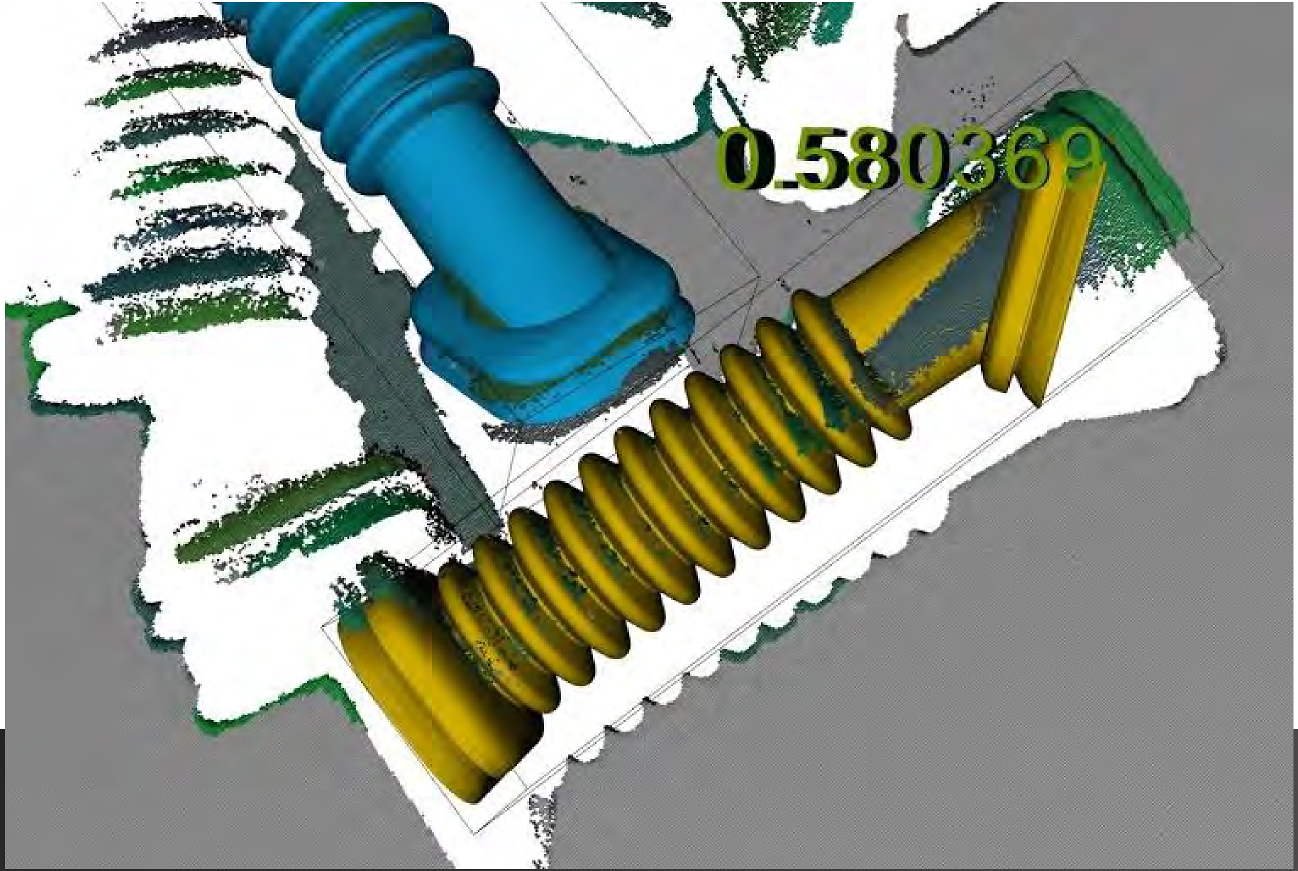
Limitations - Bending



Limitations - Self similarity - translation

?

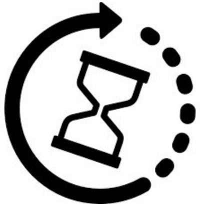
Limitations - Self similarity - rotation



Solutions

- Focus on **Surfaces**
- But also **Edges**

- Add **Machine Learning**
- Non-rigid alignment



Thanks

METHODS OF EXAMINING THE CONDITION OF WORKS OF ART IN THE CURRENT CONDITIONS OF COLLECTOR INSTITUTIONS

Veronika Gabčová [1], Branislav Horňák[2]
[1] SNG, Bratislava
[2] SNG, Bratislava

Abstract

Digital era use of current non-destructive methods in analysis of artwork condition. The application of research and the monitoring of the condition of artwork is essential in the practice of conservators, restorers, curators. From collected results we summarize the most important information about the artwork condition, so we can exactly define further professional procedures for research and protection. We will introduce you to our experience of using digital technology; the possibilities of methods and research are extensive, combined and interpreted.

SNG

Methods of examining the condition of works of art in the current conditions of collector institutions

akad. mal. Veronika Gabčová PhD.

Mgr. Branislav Horňák

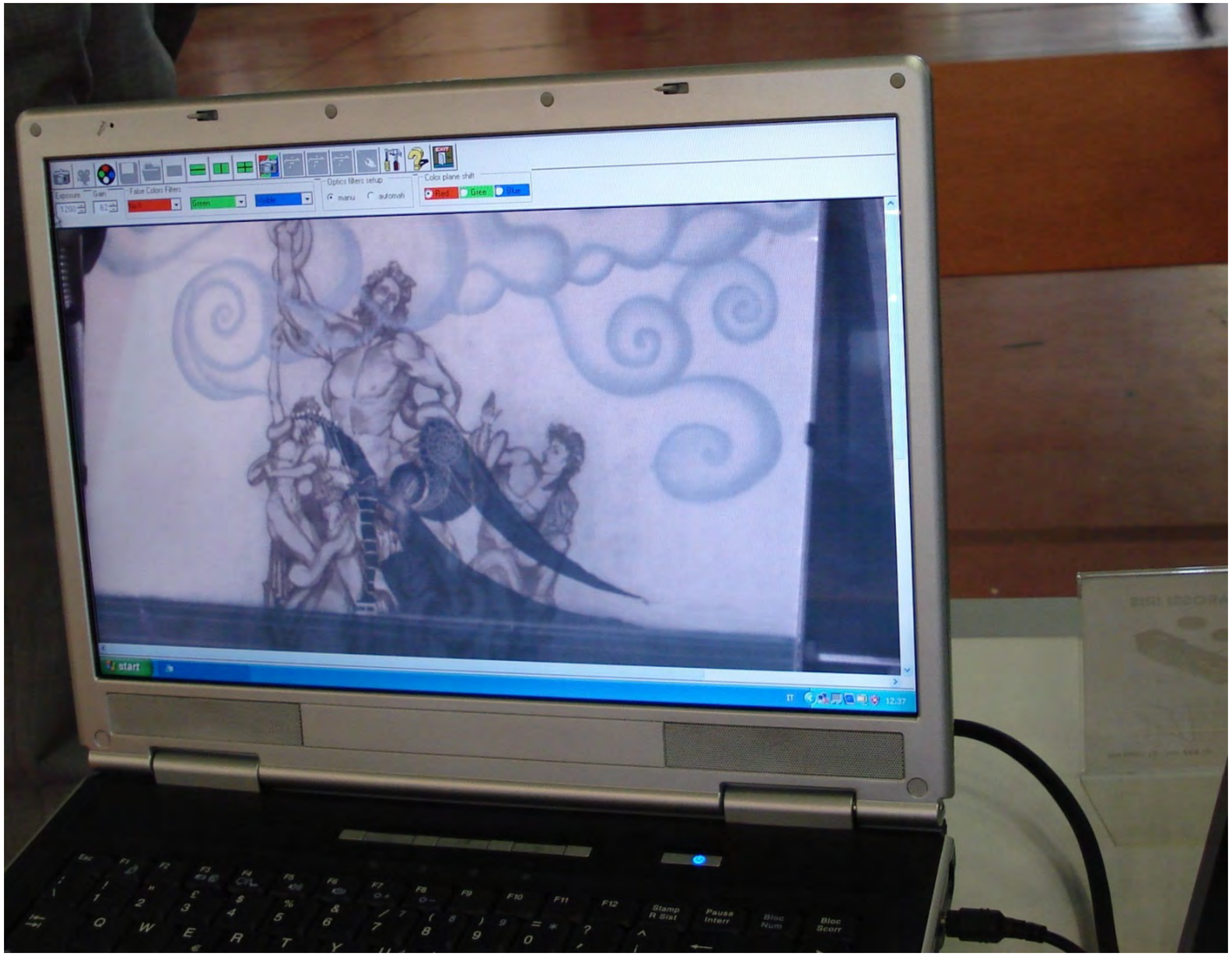
... how to use digital technology and data ...

... what reveals the digital era in the protection of cultural heritage ...

Digital era

- use of current non-destructive methods in analysis of artwork condition
- the application of research and the monitoring of the condition of artwork is essential in the practice of conservators, restorers, curators
- from collected results we summarize the most important information about the artwork condition, so we can exactly define further professional procedures for research and protection
- we will introduce you to our experience of using digital technology, the possibilities of methods and research are extensive, combined and interpreted

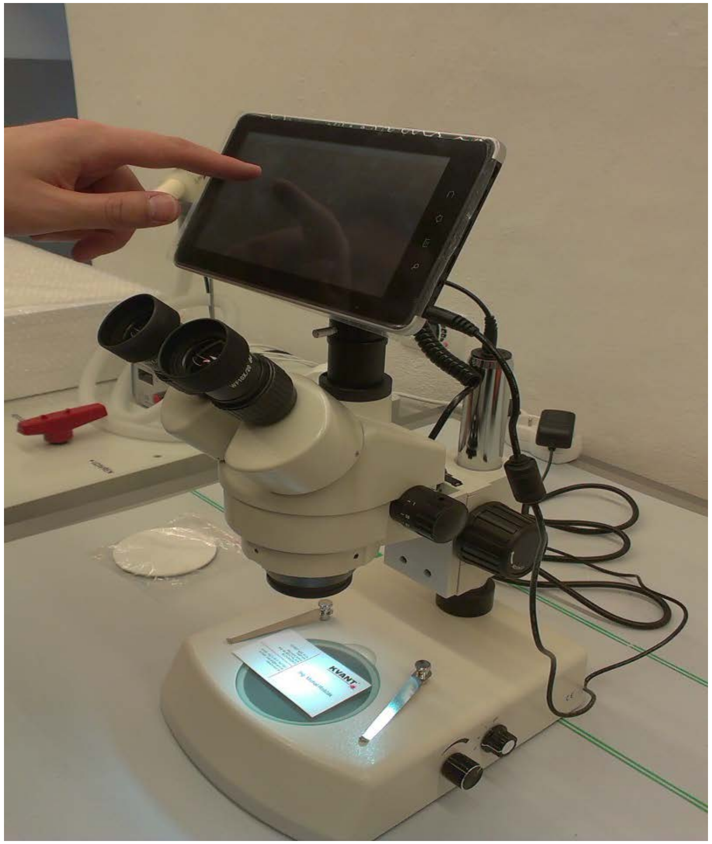
Development in everything



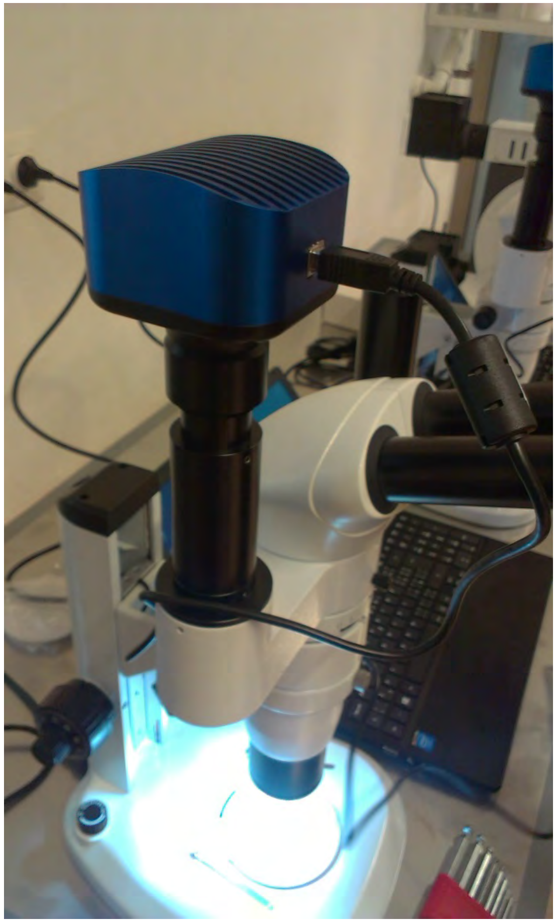
Optical instruments

Monitor microscopy 2007

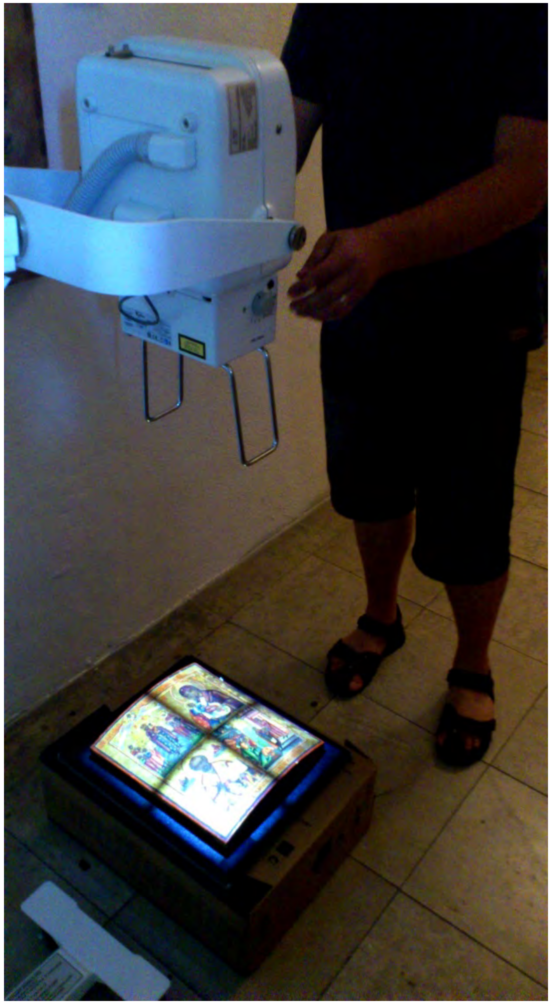
Monitor microscopy 2015



Optical instruments analysis



Instruments in the field of ionizing radiation

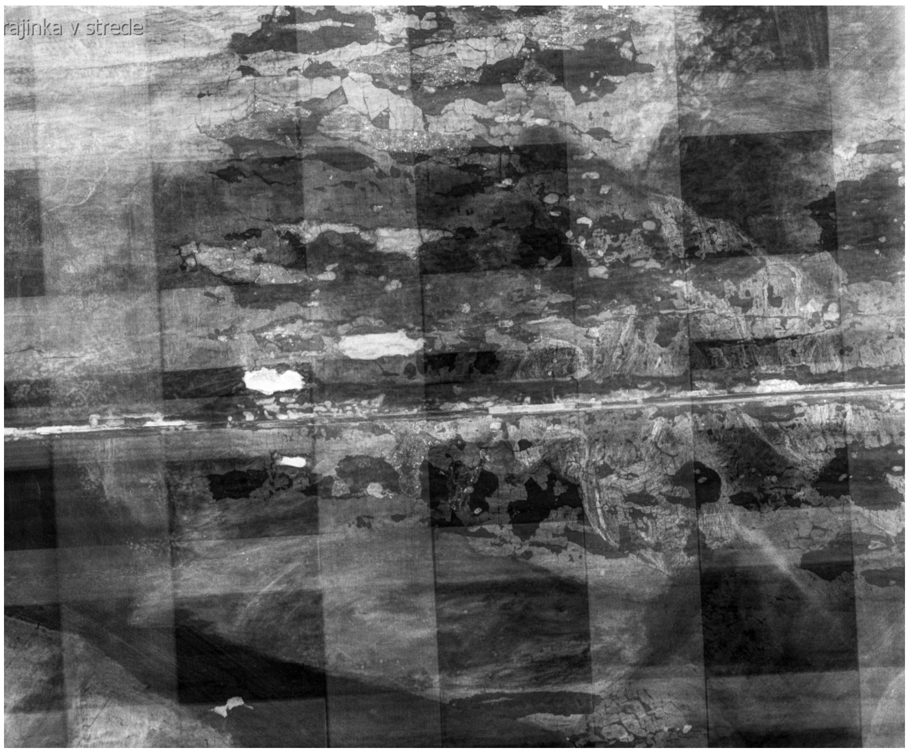


Research using X-ray

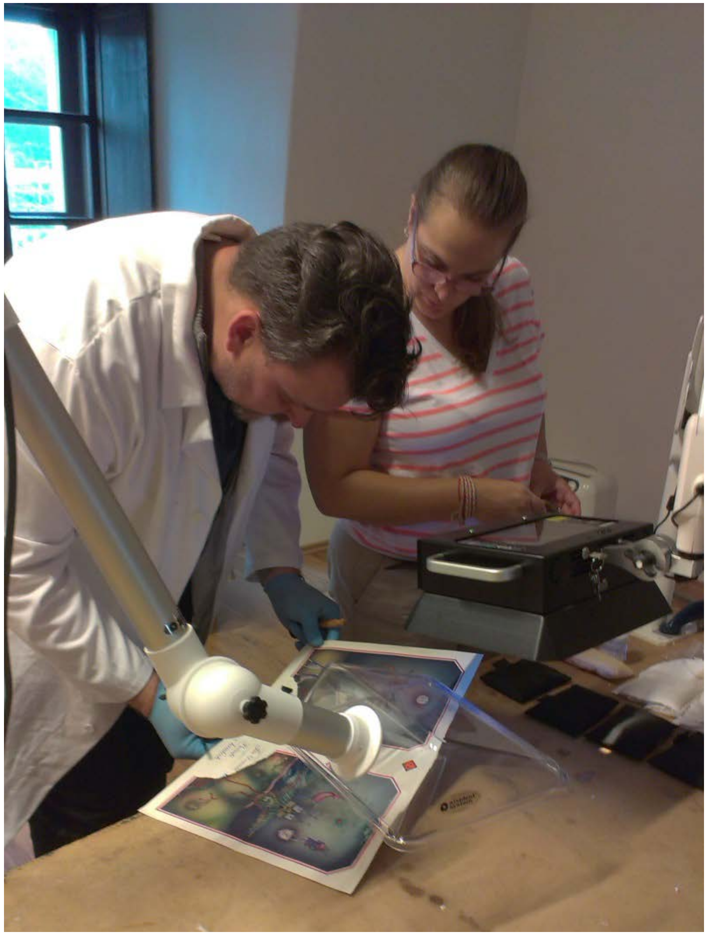
.....immediate information...

Immediate information
Non-destructive research

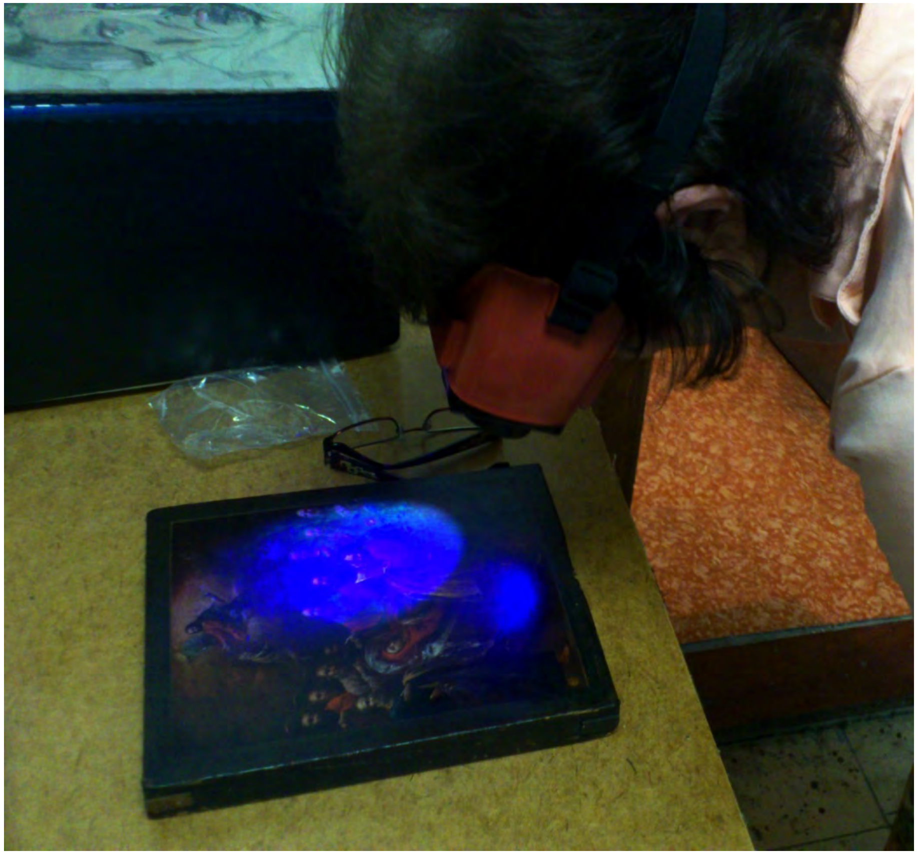
Mapping the research and the process of restoration interventions



Forensic diagnostics



Forensic diagnostics for screening on-site



Allows flexibility in on-site and off-site

Non-destructive research in the spectra

UV spectrum

Digital post-processing

….. degradation of paper ….

... highly active mold visible to the naked eye ...

Digitalization of 2D artwork

LARGE FORMAT SCANNER

Device parameters:

- trilinear sensor
- 14200 (x cca 47000) pixels
- 200 – 2000 ppi
- scan 1:1
- max. 1500 x 2500 x 200 mm
- changeable focus plane

Original Lighting System:

- **Real color**
  - the possibility of calibration and profiling
  - Parameter stability

- **ariable lightning**
  - scattered light
  - directional light
  - variable angle of illumination

Symmetrical diffused light.
True colors at every point.

Directional light.
Capture of the surface structure.

JOHANNES KUPEZKI.

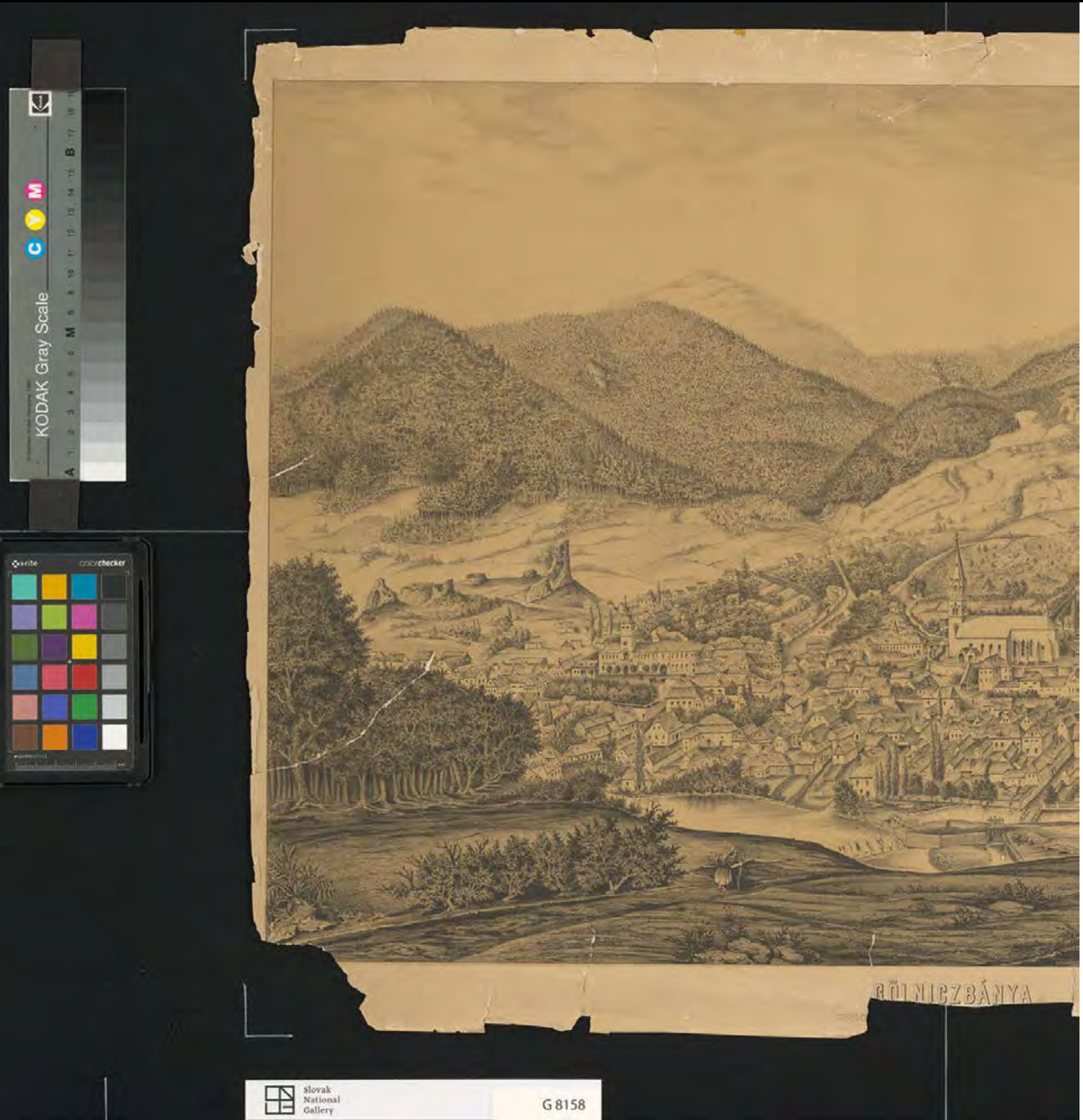
Dieſer war ſeinem Vaterland nach ein Böhm, von wannen ſeine Eltern der Eifer für ihren Gottesdienſt wegtrieb, und ſie nach den Ungariſchen Gränzen, nach Peſing brachte, wo er 1667. gebohren ward. Er hatte noch drey Brüder, Jurga, Ferenz, und Martin, und eine Schweſter Maria.

Seine Erziehung war nach dem Verhältniſs ſeines Standes nicht unglüklich, bis ihn ſein Vater zwingen wollte das Handwerk eines Webers zu lernen, wovor ihm ekelte. Da er ſeinen Vater unbeweglich fand, entſchloſs er ſich in einem Alter von 15. Jahren darvon zu gehen. Jezt muſste er betteln; doch blieb er unerſchüttert und kam von der Vorſicht geleitet zu dem Schloſs eines Grafe [illegible] ward dieſes von einem Mahler

FULL IMAGE
Original size – 106 x 162 mm

DETAIL
Scan resolution – 2000 ppi

Scan Result - MASTER



MASTER

- unedited scan
- without additional edits
- advisory scales
- identifier

Technical parameters:

- TIFF uncompressed
- RGB 48 bit
- 1:1 at given resolution
  embedded device profile
- scanner settings saved in
  metadatas

Enhanced Surface Capability ...

High-dynamic-range Imaging

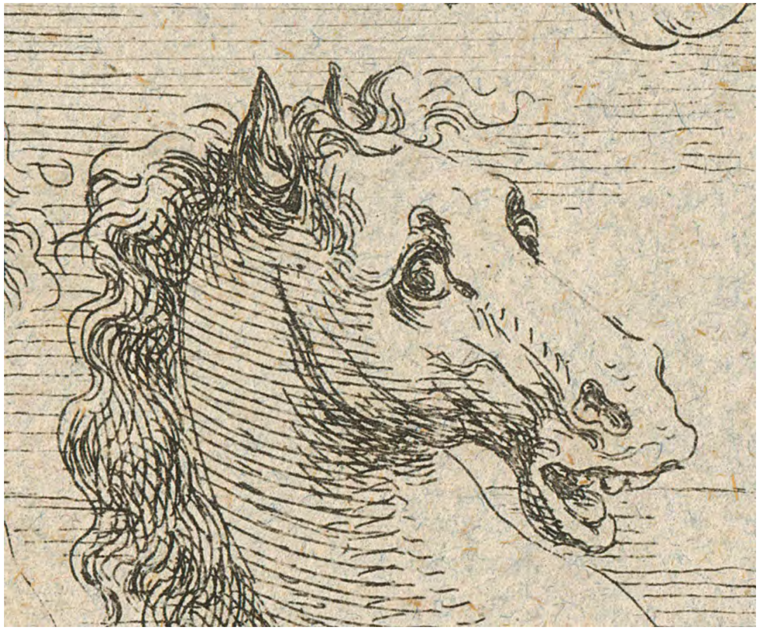
– color

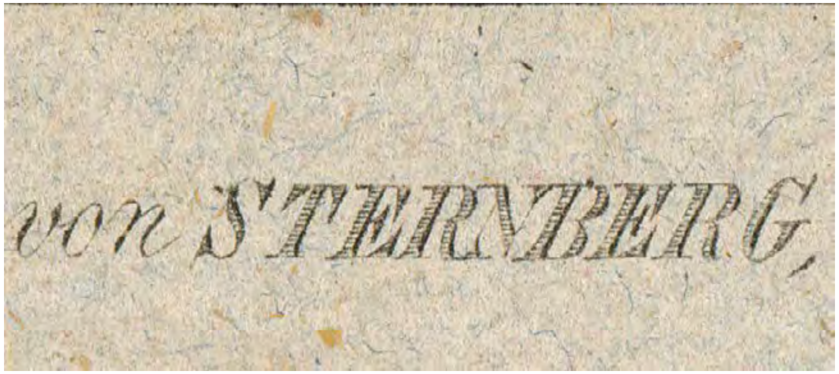
Multi-light Imaging

– surface structures

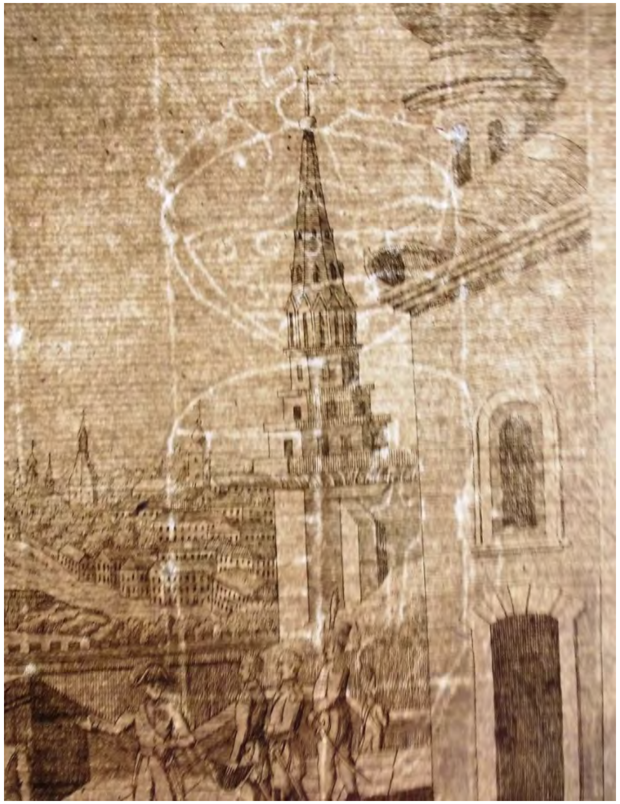
Ideally, using a large-format scanner to maintain the benefits of scanning before a digital photo.

Readable details

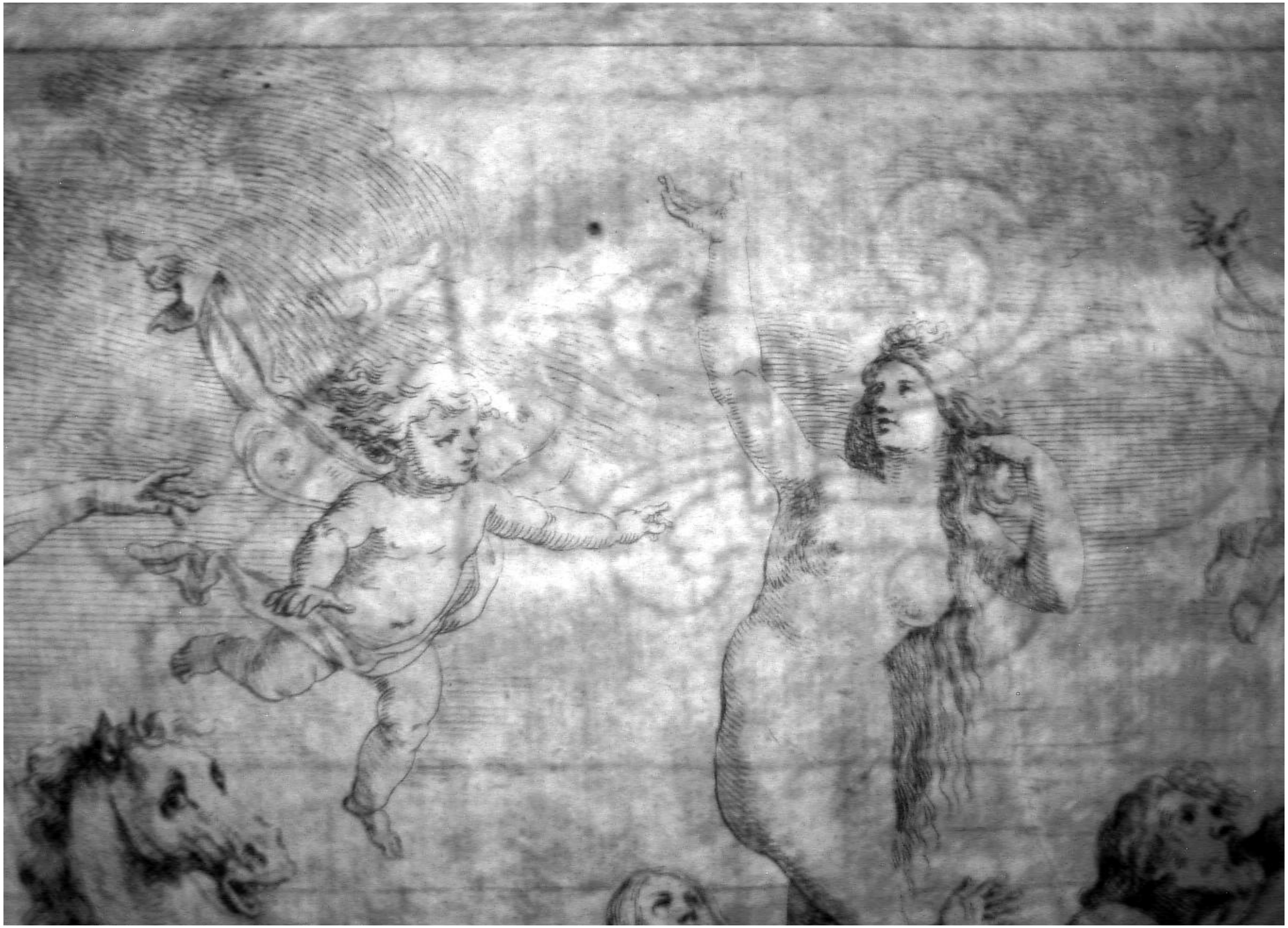




Digital technology helps to identify specific details of artwork



WATERMARK



Digital zoom of the scan detail reveals the print raster

...use with 3D objects...

3D Objects - The current state of digital documentation

2D images from 6 points of view, additional images (important detail, moving parts ...) scanned with a control color scale.

Mid-format digital camera,
60 Mpx,
6708 x 8956 pixels

Documentation of artwork condition, presentation and publishing purposes. Limited professional use.

Documentation and planning of restoration interventions, other specific needs - the need to create separate digital records, still 2D.

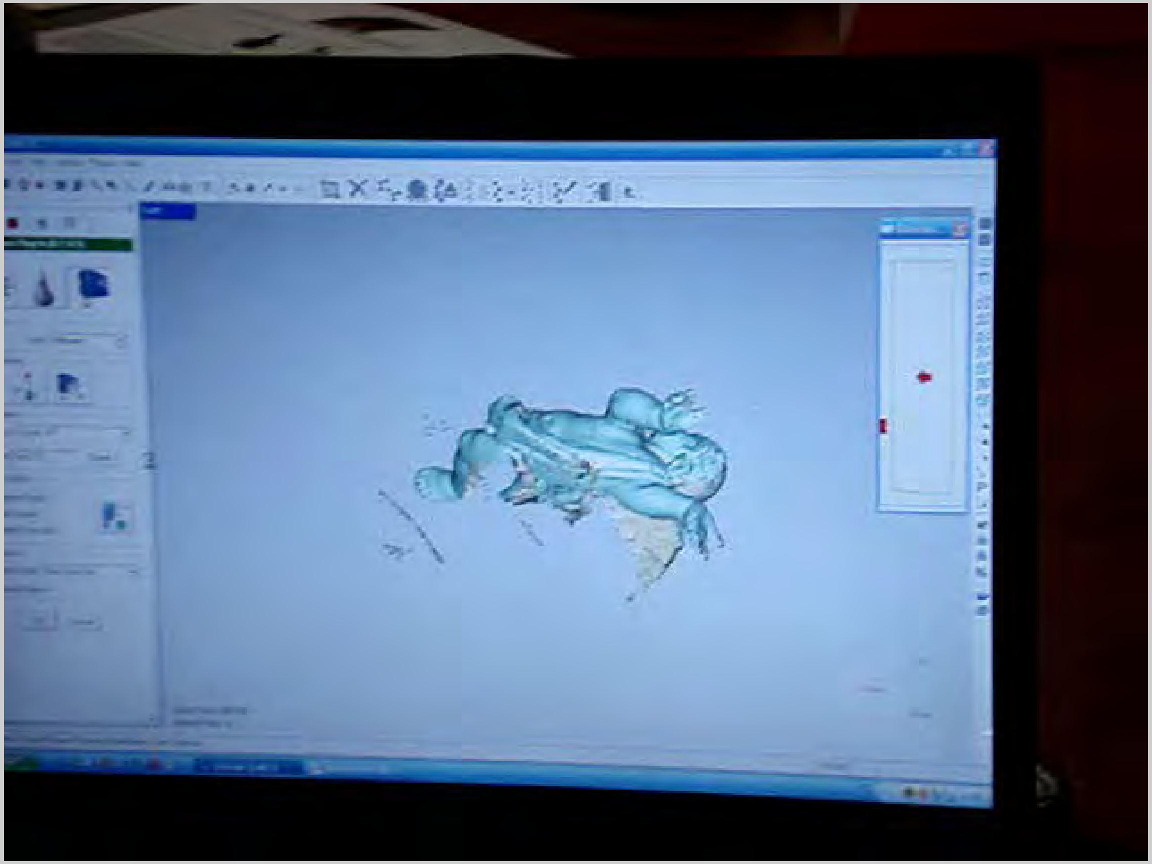
3D Objects - Requirements for digitalization

- Accuracy and resolution of a 3D model;
- Real color fidelity and high texture resolution;

3D Objects - Requirements for digitalization

- Dealing with problematic patterns (high gloss / gold, dark surfaces, broken objects / jewelry ...)

3D Objects - Requirements for digitalization

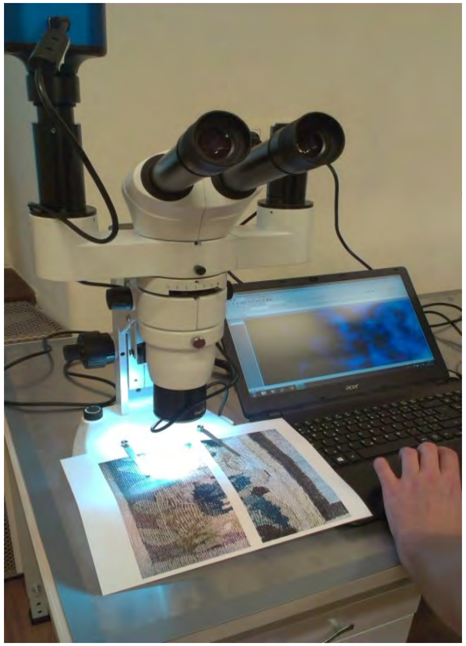


- acceptable difficulty of post-processing of the data obtained;
- the ability to work with a digital model on common devices;

Current possibilities in SNG Our orientation in the development of artworks

- UV, IR, RTG, SKEN, forensic diagnostics, monitor microscopy, mass spectrometer, profilometry, other spectra - methods of non-destructive research
- specialized workplaces, natural sciences, technical character - laboratory of chemical technology optical instruments - analysis of sophisticated workplaces
- digital recording technology, recording, systematic database of on-site objects status

Specialized workplace SNG Zvolen



...research,
analysis,
restoring...

The outputs of this three-dimensional research are:

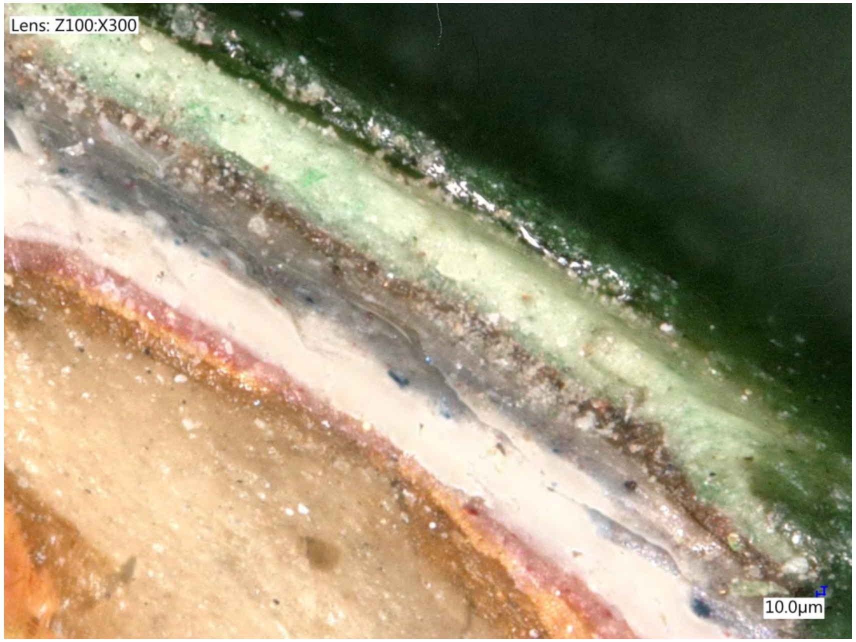
- current records of our artwork condition and work on-site - external conditions
- procedures and conditions for manipulation with objects, recommendations for specialized professional activities eg. fumigation
- using the information of new digital technologies to evaluate the degradation process
- the methodology of other practical outputs for future use of digital photo data and scanning as a research material

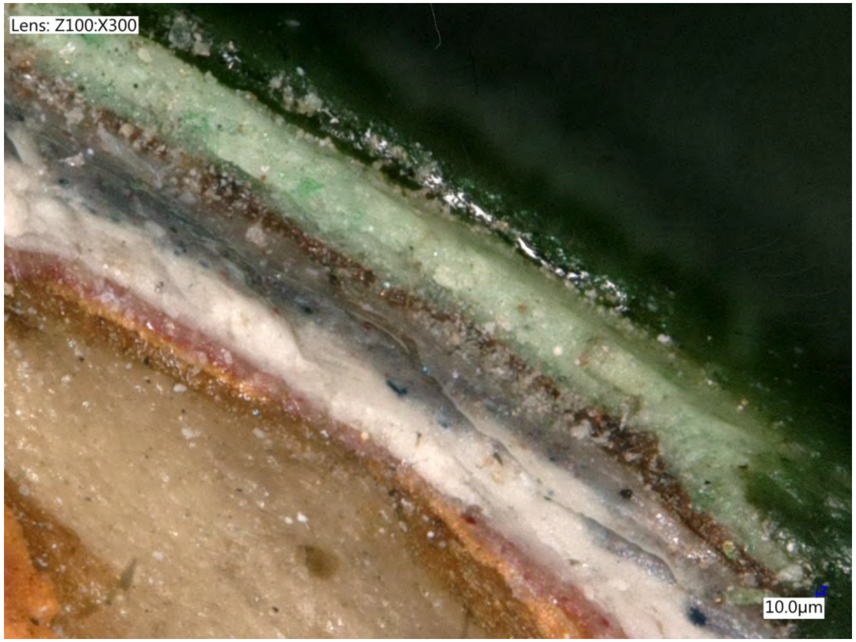
What awaits us....

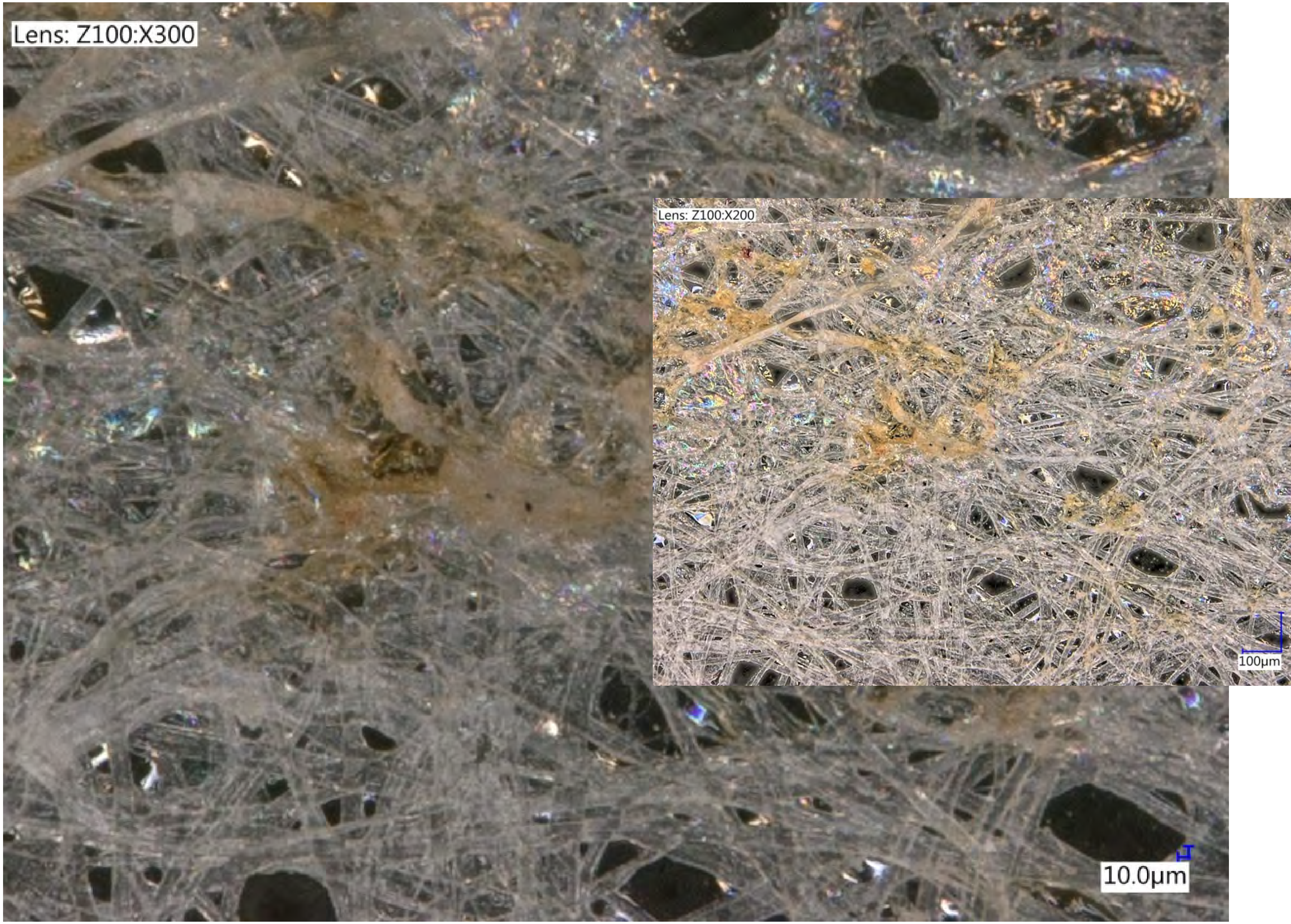
- Visions for the future of collector institutions and their target programs - prevention, protection, monitoring, presentation
- New procedures for data retrieval, storage, and presentation
- Interdisciplinary approaches and cooperation with specialized workspaces

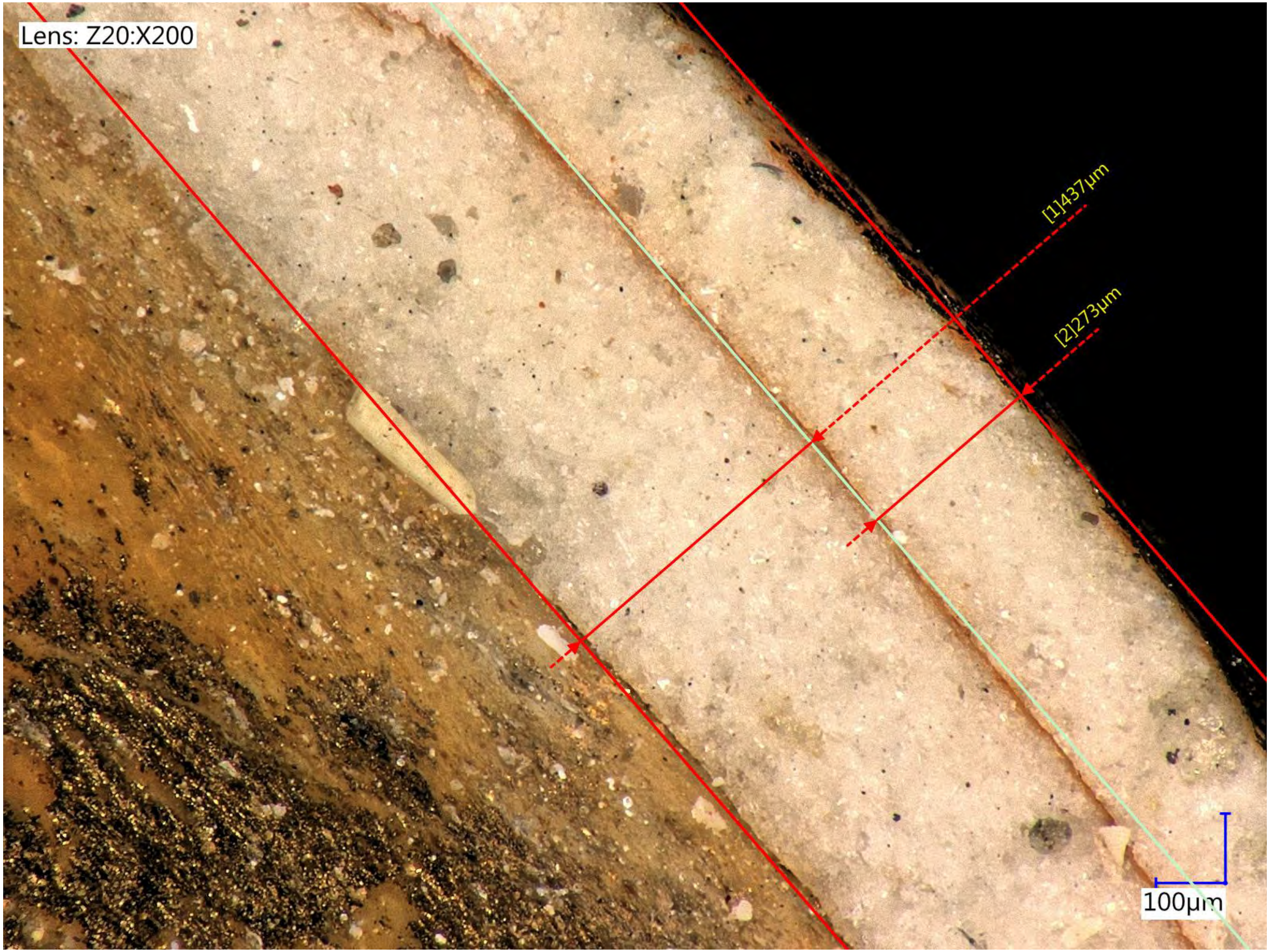
VHX-5000 DIGITAL MICROSCOPE
lens 300xmicro

Non-destructive methods which allows us to see details of the damage ....



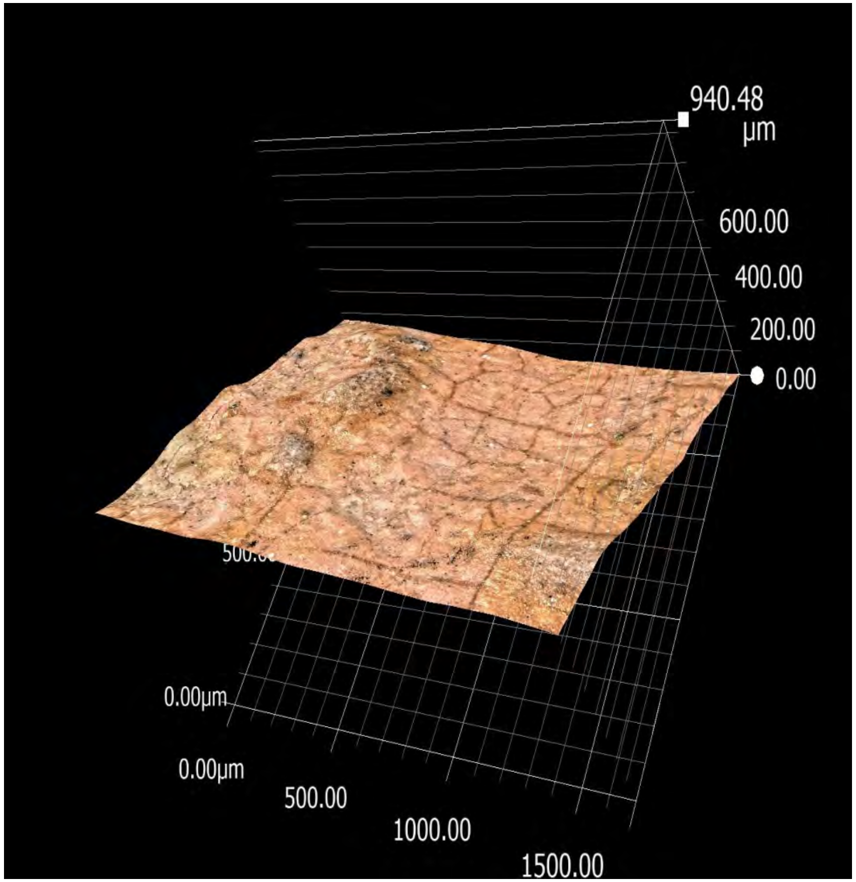


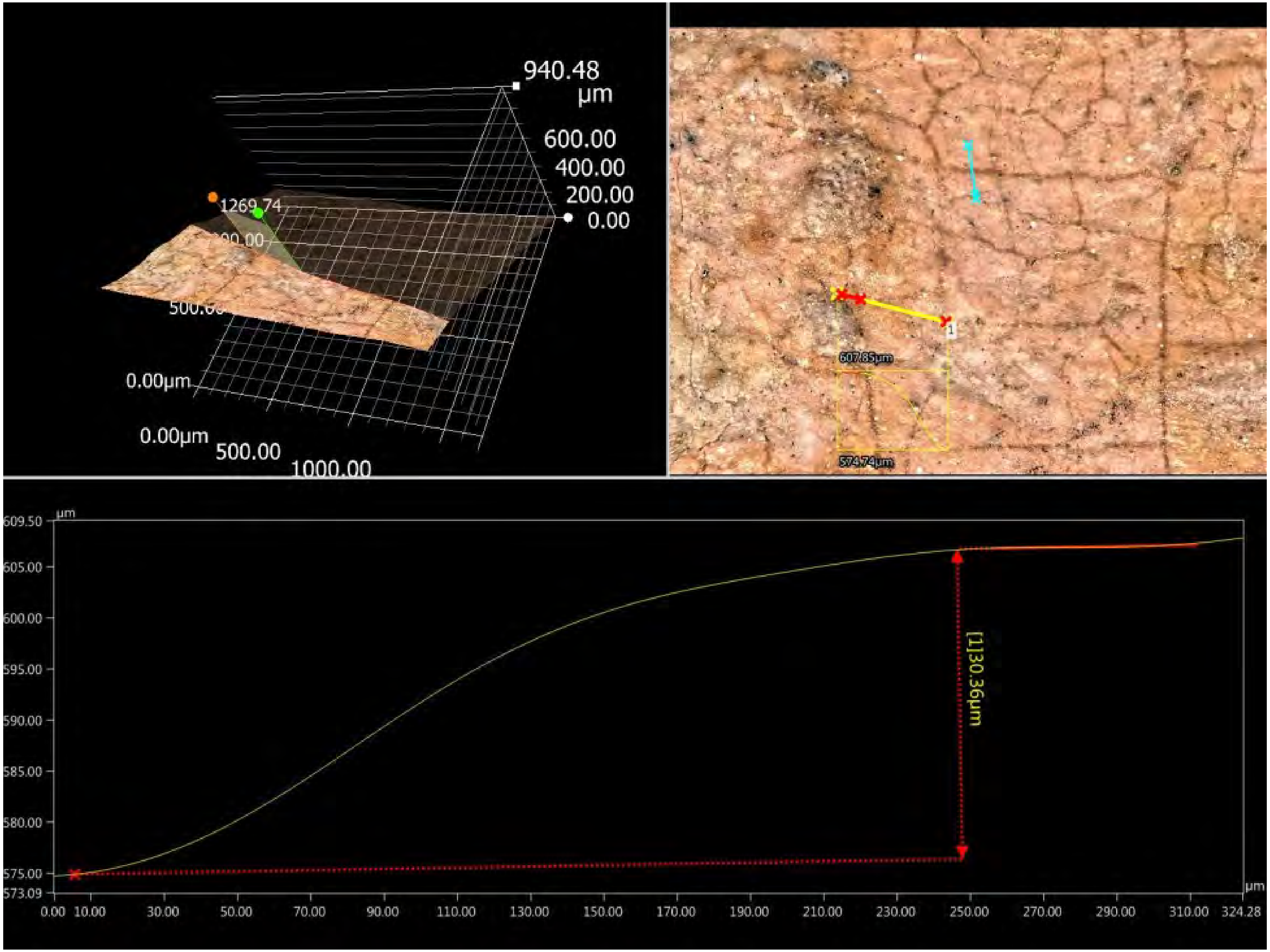

Lens: Z100:X300
10.0µm
Lens: Z100:X200
100µm



Lens: Z20:X200
[1]437µm
[2]273µm
100µm

Topography of the surface from the image of the micro world




940.48 µm
600.00
400.00
200.00
0.00
1269.74
0.00µm
0.00µm
500.00
1000.00
607.85µm
574.74µm
µm
609.50
605.00
600.00
595.00
590.00
585.00
580.00
575.00
573.09
[1]30.36µm
0.00 10.00 30.00 50.00 70.00 90.00 110.00 130.00 150.00 170.00 190.00 210.00 230.00 250.00 270.00 290.00 310.00 324.28

THANK YOU FOR YOUR ATTENTION

3D WOOD ANALYSIS USING EELECTRON MICROSCOPE

Miroslava Mamoňová[1]
[1] Technical University in Zvolen, Slovakia

Abstract

The introduction of the lecture Electron Microscopy and Study of Woody Structures deals with the specific preparation of specimens for SEM (scanning electron microscopy) and with the major difficulties of this process, while the attention is paid to the uniquely developed preparation procedures of historical wood characterized by its fragility, limited amount of sampled material and various degree of degradation caused by fungi or insect. For degraded, as well as extremely hard wood specimen, the methodology using Daucus carota was suggested and verified.

Every preparation procedure is unique and developed in dependence upon the characteristics of the object of observation and requirement for the resulting scans to show the required information.

The lecture illustrates the color gallery of SEM scans of woody structures processed via ImageProcessing. Subsequently, the lecture discusses the research topics studied at the Workplace of electron microscopy of the Technical University in Zvolen, including a brief overview of studies using SEM Tescan Vega with a significant impact, whose results were published in prestigious scientific journals.

The core of the lecture includes new 3D SEM applications and images carried out in Tescan Orsay Holding, a.s. Brno, with following points being discussed:

1. 3D model of reconstructed brushed surface of a wood log house specimen, Nižná Boca, using software module Mex with FE-SEM Mira 3, Tescan. The measurement results of specimen profile are given.

2. High resolution imaging of tracheid pitting in radial walls of white fir wood (Abies concolor (Gordon) Lindl. ex Hildebr.) with the occurrence of warty layer (Magnification: 76400x) and taxodioid cross-field pits; bordered pit of Scots pine wood (Pinus sylvestris L.), while the InBean detector was used for imaging the microfibrillar structure in secondary wall of compression wood tracheids. We document also formation of gold granules on coated xylem specimes, which can hide the subtle finesses of nanostructures (Magnification: 84600x).

3. Cryo SEM imaging of cross-section break zone of tension wood fibres in Fagus sylvatica using SEM Tescan Lyra3. A visible lamella structure could be observed this way for the very first time.

4. Dual beam FIB-SEM (Focused ion beam scanning electron microscopy) system applied on libriform fibres and beech parenchyma cells of rays (Fagus sylvatica L.), scanned using LYRA3 Tescan equipped with ion-optics with highly stable Ga+ LMIS source (Cobra column).

The last part of the lecture is devoted to the results of material research into wood elements of structures in the National Cultural Monument Krásna Hôrka, the National Cultural Monument Ľupčiansky hrad and historical roof frame structures in Premonstrate Monastery in Želiv, Czech Republic.

Acknowledgement:

This study was created thanks to the enthusiasm of Ing. Jana Havránková and Ing. Kristína Rosíková, who were immensely helpful with applying individual methods of the company Tescan Orsay Holding, a.s. Brno.

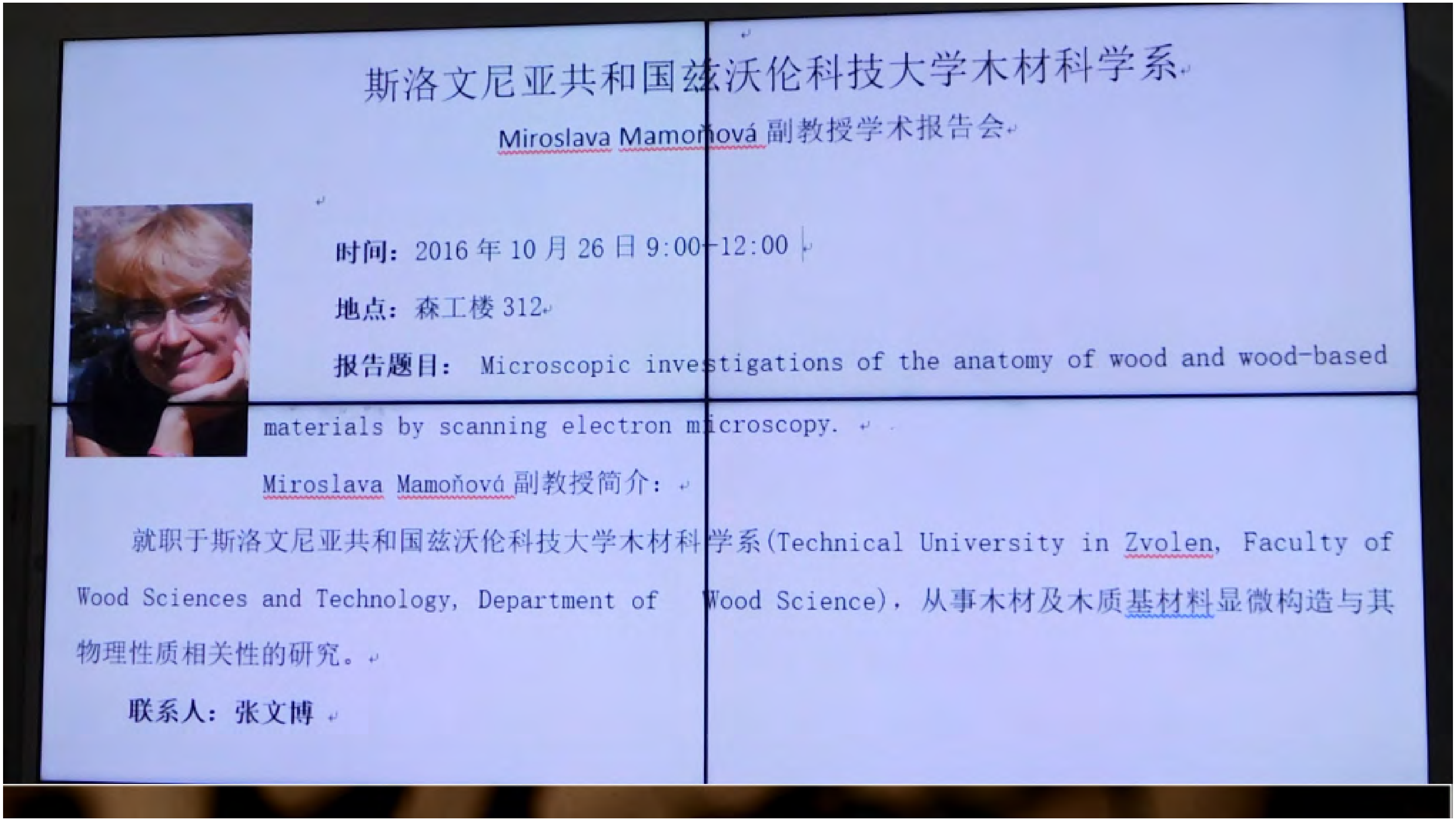
I would like to thank also to the Department of Special Measuring Technology of the company Kvant, s.r.o. Bratislava, for general help and support.

This lecture was funded by the following grants: the Scientific Grant Agency of the Ministry of Education SR and the Slovak Academy of Sciences (Grant No. 1/0822/17 "Surface modification of wood and coating materials in order to improve stability of the wood – coating material system."). This lecture has been included into the project APVV-16-0177 "Progressive modifications of the wood surface, film-forming materials and their interactions at the phase interface."

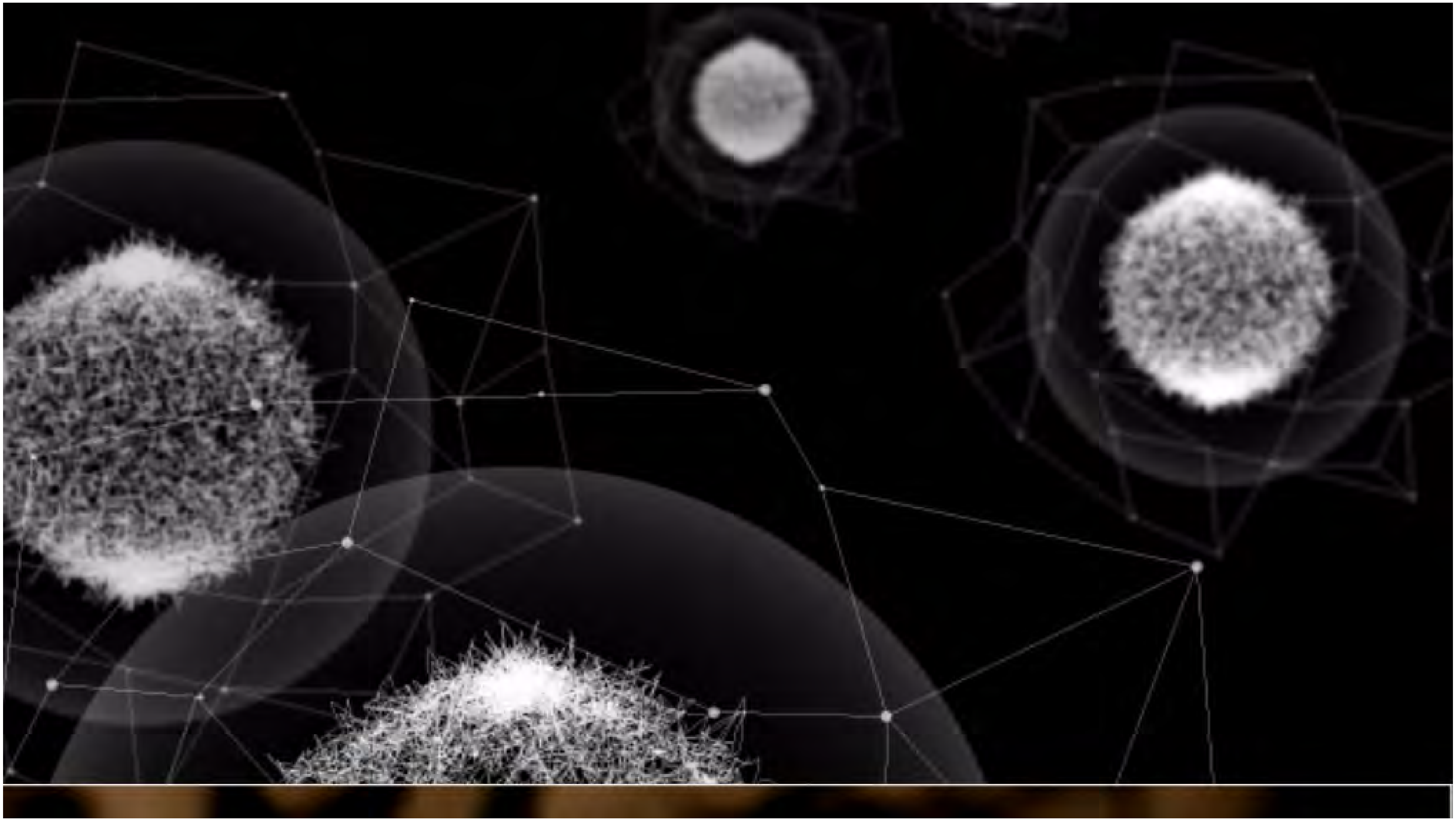

DREVÁRSKA FAKULTA
TECHNICKÁ UNIVERZITA VO ZVOLENE
21.–22. SEPTEMBER 2017
MEDZINÁRODNÁ KONFERENCIA na tému: 3D MERANIE A ZOBRAZOVANIE
Elektrónová mikroskopia a štúdium drevných štruktúr
Ing. Miroslava Mamoňová, PhD.
22. 9. 2017
Elektrónová mikroskopia
Nové 3D aplikácie a zobrazenia
Materiálový prieskum historických objektov
2. ročník 3D meranie a zobrazovanie
Zobrazovanie a moderné diagnostické metódy v priemyselnej praxi
SEM MAG: 4000 x
DET: SE Detector
20 µm
Vega©Tescan


DREVÁRSKA FAKULTA
TECHNICKÁ UNIVERZITA VO ZVOLENE
21.- 22. SEPTEMBER
2017
MEDZINÁRODNÁ
KONFERENCIA
na tému:
3D MERANIE
A ZOBRAZOVANIE
Elektrónová mikroskopia
a štúdium drevných
štruktúr
Ing. Miroslava Mamoňová, PhD.
22. 9. 2017

2.


斯洛文尼亚共和国兹沃伦科技大学木材科学系
Miroslava Mamoňová 副教授学术报告会
时间：2016 年 10 月 26 日 9:00-12:00
地点：森工楼 312
报告题目： Microscopic investigations of the anatomy of wood and wood-based materials by scanning electron microscopy.
Miroslava Mamoňová 副教授简介：
就职于斯洛文尼亚共和国兹沃伦科技大学木材科学系(Technical University in Zvolen, Faculty of Wood Sciences and Technology, Department of Wood Science)，从事木材及木质基材料显微构造与其物理性质相关性的研究。
联系人：张文博

3.



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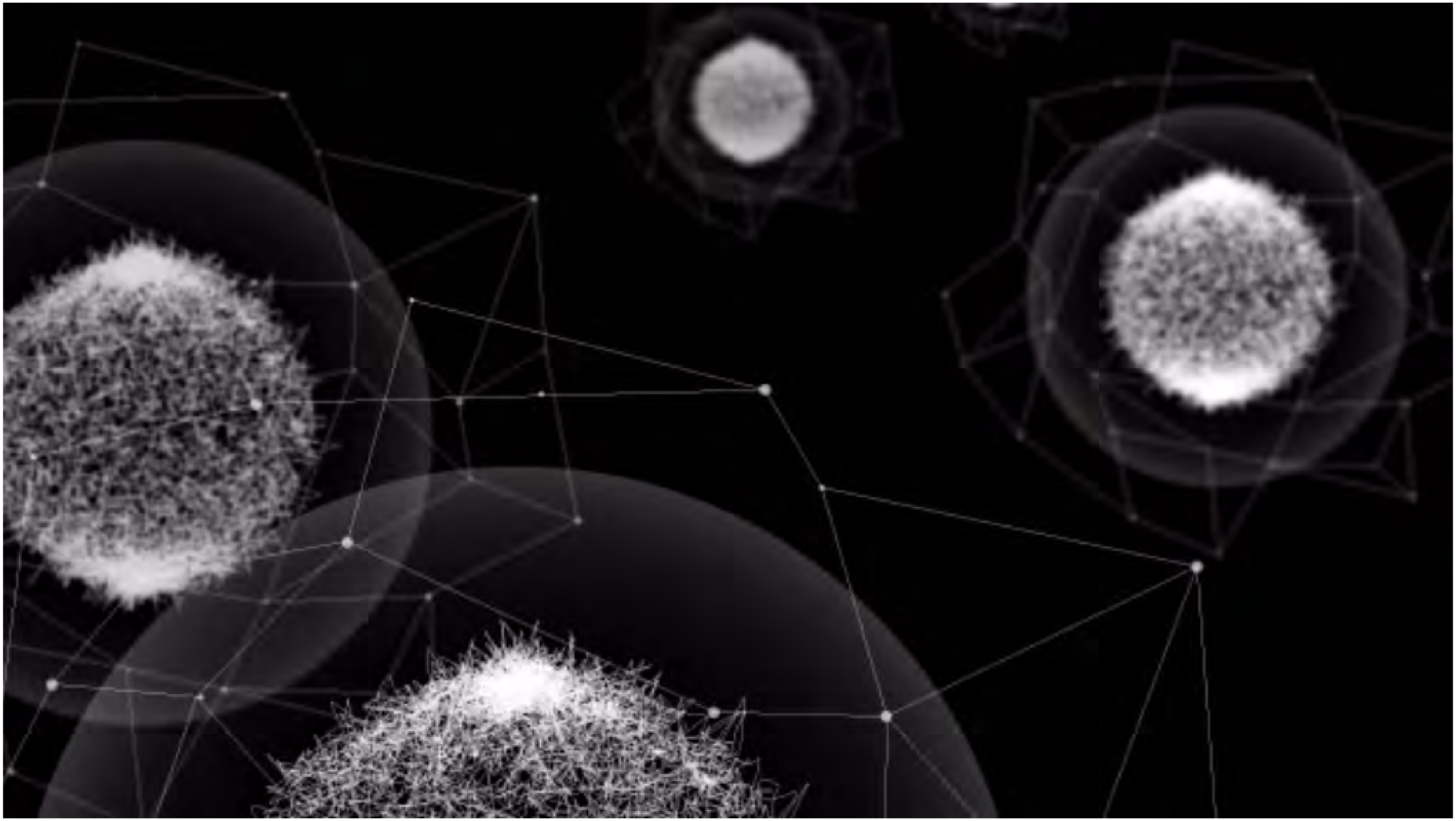


5.


Elektrónová mikroskopia
Drevo – anatomický pohľad
Možnosti zobrazenia – SEM Tescan Vega
Špecifická príprava preparátov
Galéria
Predmet skúmania

6.

Elektrónová mikroskopia

- Drevo – anatomický pohľad
- Možnosti zobrazenia – SEM Tescan Vega
- Špecifická príprava preparátov
- Galéria
- Predmet skúmania

- Nové 3D aplikácie a zobrazenia
  Tescan Mira3, FIB-SEM TescanLyra3
- Materiálový prieskum drevených prvkov konštrukcií NKP Krásna Hôrka a NKP Slovenská Ľupča
- Materiálový průzkum krovových konstrukcí v Klášteře premonstrátů v Želivě

Makrosvet dreva

- **Drevo ako čierna krabička** – fyzici dreva, mechanici dreva

- Drevo je **najuniverzálnejší materiál na zemi**
- **Atribúty**, nielen vynikajúcich mechanických vlastností, ale pripisuje sa mu schopnosť dýchať v priestore, naše estetické cítenie je úzko späté s drevom – vnímame ročné kruhy, má teplé farebné odtiene

9.

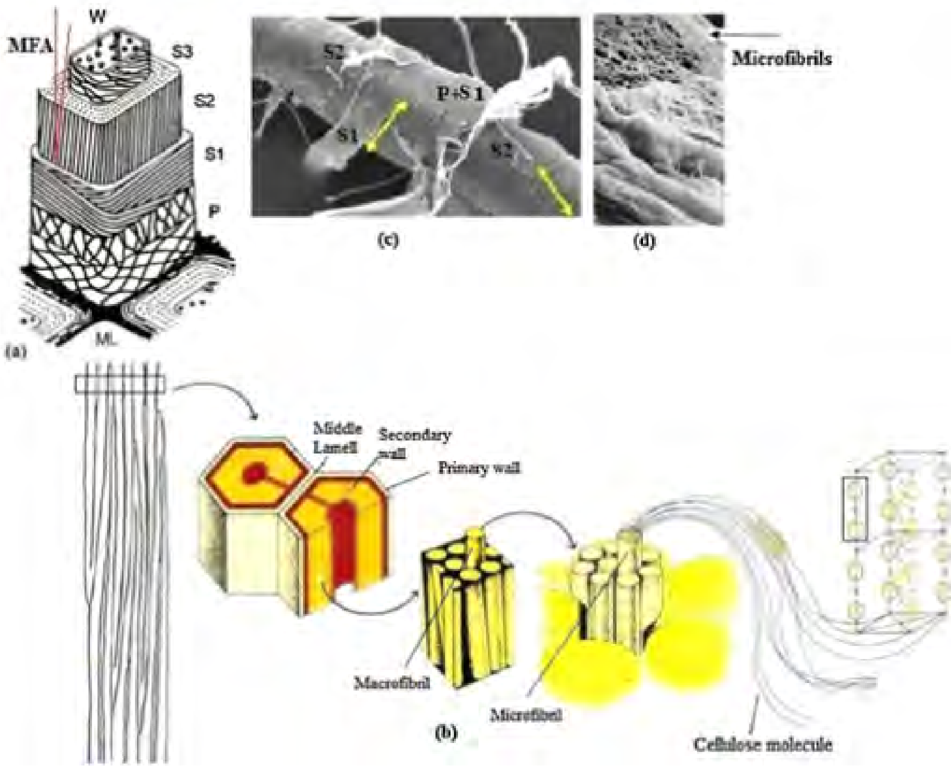
Mikrosvet dreva

- **Z hľadiska anatomického** je najporozuhodnejším – **vlákno dreva** - dĺžka je 100 až 200 násobne dlhšie ako jeho priečne rozmery
- Štruktúra steny vlákien - dlhé reťazce kryštalickej celulózy, ktorých zväzky sa nazývajú **mikrofibrily.**

- **mikrofibrily** - vytvárané **rozetami** - na koncoch vlákien
  Rozety sú vynikajúcimi príkladmi prirodzenej nanotechnológie

- Fascinujúca tvorba stien vlákna - proses premenlivého uhla mikrofibríl nebol dodnes objasnený ▸ tri rozdielne vrstvy

Mikrosvet dreva

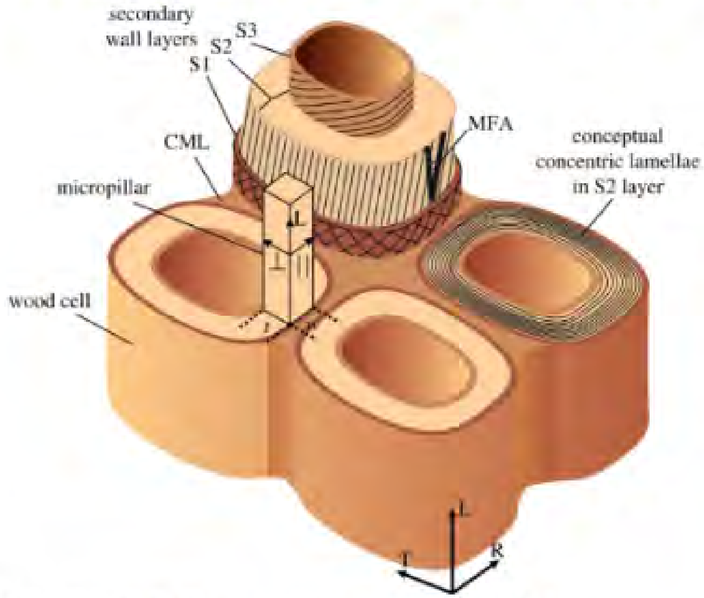


Obrázok 1 Štruktúra vláknitej bunky dreva

a) vrstvy bunkovej steny (stredná lamela /**middle lamella** (ML), primárna stena/ **primary wall** (P), sekundárna stena/**secondry wal** (S1, S2, S3), lúmen s bradavičnatou vrstvou/**warty layer** (W);

(b) fibrilárna štruktúra bunkovej steny;
(c) SEM obraz vrstiev bunkovej steny; d) SEM mikrofibríl

Mikrosvet dreva

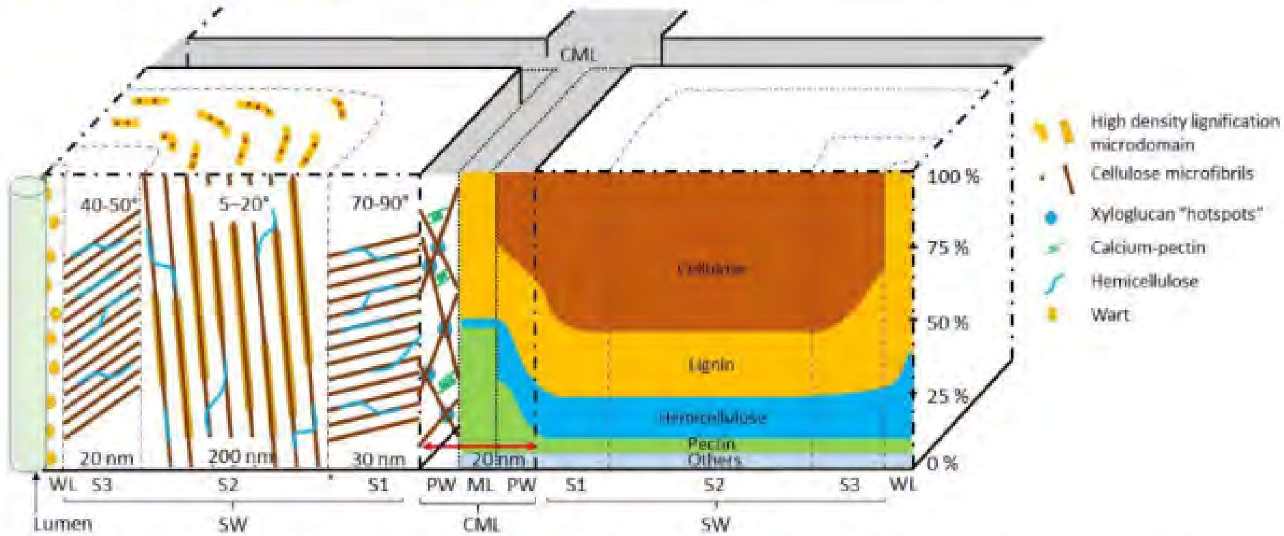


Obrázok 2 Koncept koncentrických lamiel v S2
Uhol medzi celulózovými fibrilami a pozdĺžnou osou bunky - uhol mikrofibríl, MFA

Fascinujúca tvorba stien vlákna - proses **premenlivého uhla mikrofibríl** nebol dodnes objasnený ▸ tri rozdielne vrstvy

Vieme:
▸ stredná vrstva **(S2)** - **najhrubšia** a uhol mikrofibríl tejto vrstvy má dramatický vplyv na vlastnosti vlákien a dreva ▸ vplýva na pevnosť, pružnosť a zosýchanie dreva ▸ **veľký uhol mikrofibríl** vrstvy bunkovej steny S2 - vlákno je pružné a tvrdé

Mikrosvet dreva



Obrázok 3 Model bunkovej steny vlákna listnatého dreva
od strednej lamely po lumen

Lignín a hemicelulózy - viažu mikrofibrily (a vlákna navzájom) a vytvárajú komplexnú štruktúru masívneho dreva

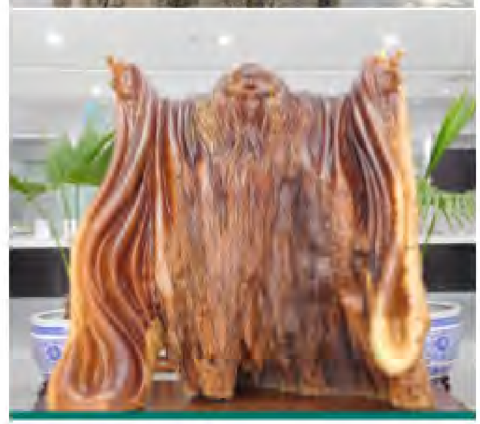
A teda čo je drevo?

- vrstevnatý materiál, anizotropný – má smery, má rezy, má odlišne orientované pletivá
- **rozmanitosť druhová**:

„Na svete je približne **25 000 až 30 000 druhov dreva**, ale len 3 000 – 5 000 sa hodí na priemyselné spracovanie a obchoduje sa

len s **200 – 250** druhmi dreva“

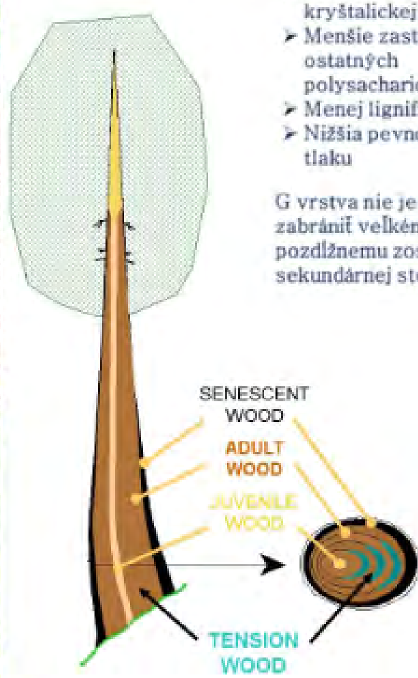
- nerovnorodá štruktúra, anizotrópia, zmena jeho rozmerov a vlastností
- **degradačné činitele**: huby, hmyz, bakteriologický rozpad – cez mikroštruktúru možno predikovať zmeny chemické, fyzikálne a mechanické
- **anomálie rastu**




银杏科
银杏属
银杏
拉丁学名：Ginkgo biloba
别名：鸭脚树、白果
生长习性：性喜光，喜温暖湿润气候
地理分布：我国各省市广泛栽培
园林应用：行道树、庭院树
花期：4月
果期：8~10月

15.

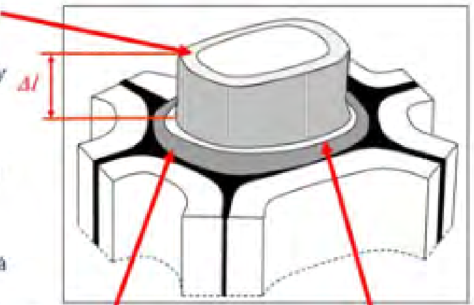
A teda čo je drevo?



G vrstva/layer

- MFA ≈ 0°
- Vyššie zastúpenie kryštalickej celulózy
- Menšie zastúpenie ostatných polysacharidov
- Menej lignifikované
- Nižšia pevnosť v tlaku

G vrstva nie je schopná zabrániť veľkému pozdĺžnemu zoschnutiu sekundárnej steny



S1 vrstva
veľký MFA
veľké pozdĺž. zoschnutie

Slabá väzba medzi
G a S vrstvami

Schéma - Reakčné ťahové (tension wood) drevo buka

- zmenené vlastnosti:
- väčšie pozdĺžne zoschnutie, vyššiu hustotu

Skenovací elektrónový mikroskop (SEM)

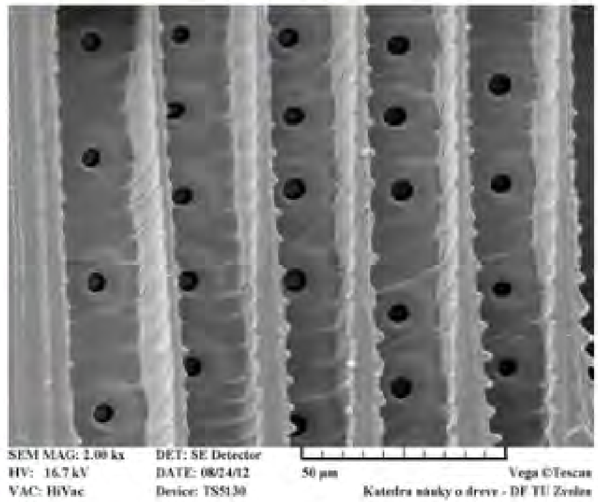
- Prednosti zobrazenia v porovnaní s optickým mikroskopom

- Príprava preparátov pre SEM, hlavné úskalia tohto procesu

Odber vzorky, fixácia preparátov, dehydratácia a sušenie preparátov, lepenie vzoriek a ich pozlátenie

- **Aplikačné možnosti** využitia zobrazovania a analýz v drevárskych a lesníckych vedách

Obrazový výstup



Obr. 5 Ilustračná fotografia z optického a skenovacieho elektrónového mikroskopu na podobnom preparáte dreva duglasky tisolistej *Pseudotsuga menziesii* (Mirbel) Franco.

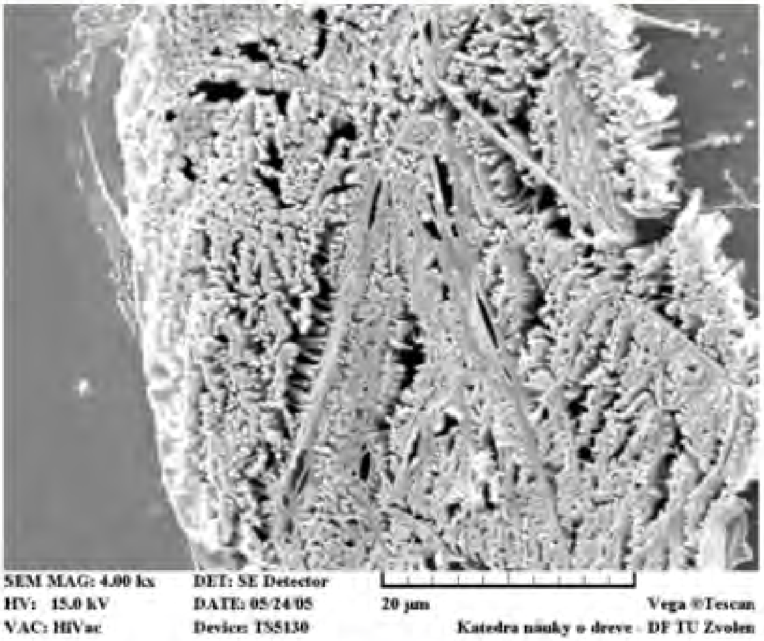
Obrazový výstup – Tescan Vega

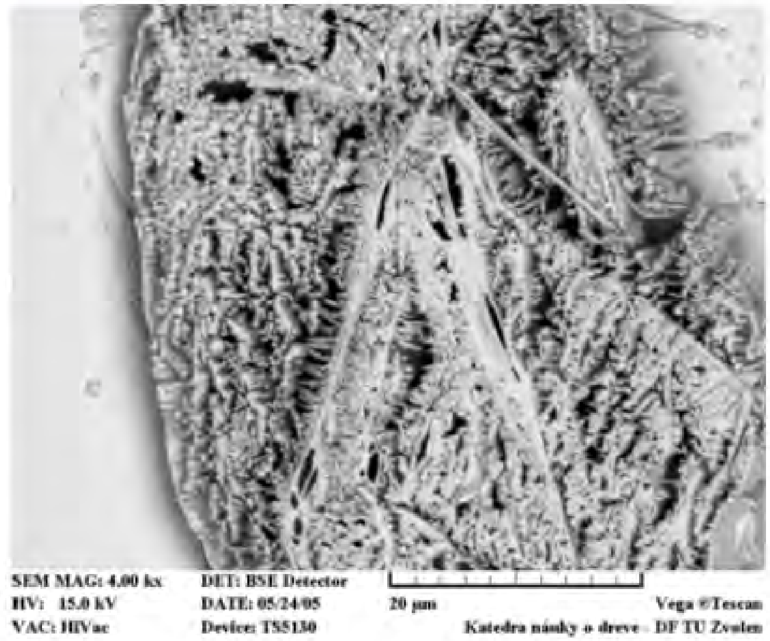
Zápis obrazu v digitálnej forme, najčastejčie vo formáte - **bitová mapa** (.bmp, **1024x864 pixels, o veľkosti 865kB**)

- **hĺbka ostrosti** –SEM fotografie - väčšia hĺbka ostrosti (3D)
  - Ideálne pre pozorovanie dôležitých diagnostických znakov - **špirálovitá výstuž, dvojbodky - anatomické detaily dreva**
- **preparáty** – pozorovanie živých a vodu obsahujúcich preparátov je pomocou SEM problematické (vysoké vákuum) – **riešením je enviromentálny mikroskop a Critical Point Drying (CPD)**
- **absencia farieb** – **256** stupňov intenzity sivej

- **SE** - zobrazenie **topografie** povrchu vzorky
- **BSE** - veľmi **citlivé na zmeny atómového čísla**

Výstup SE-BSE signálov

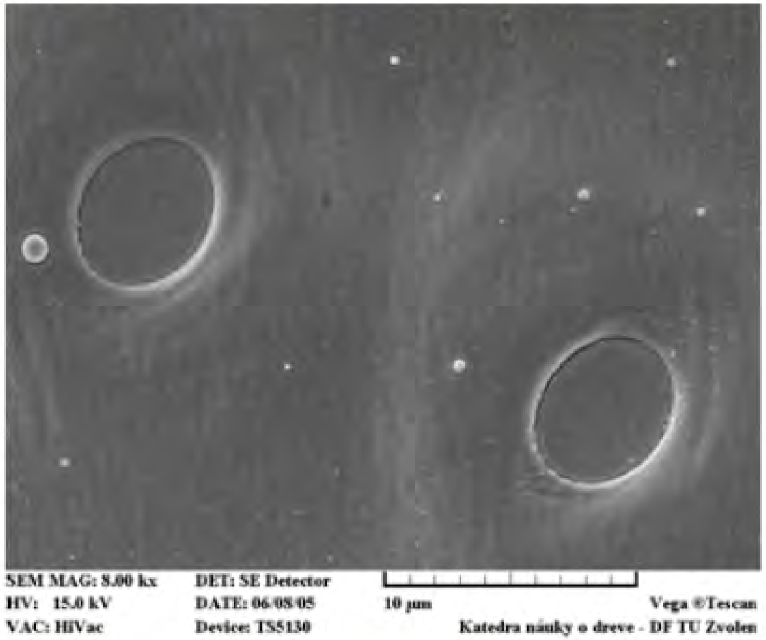


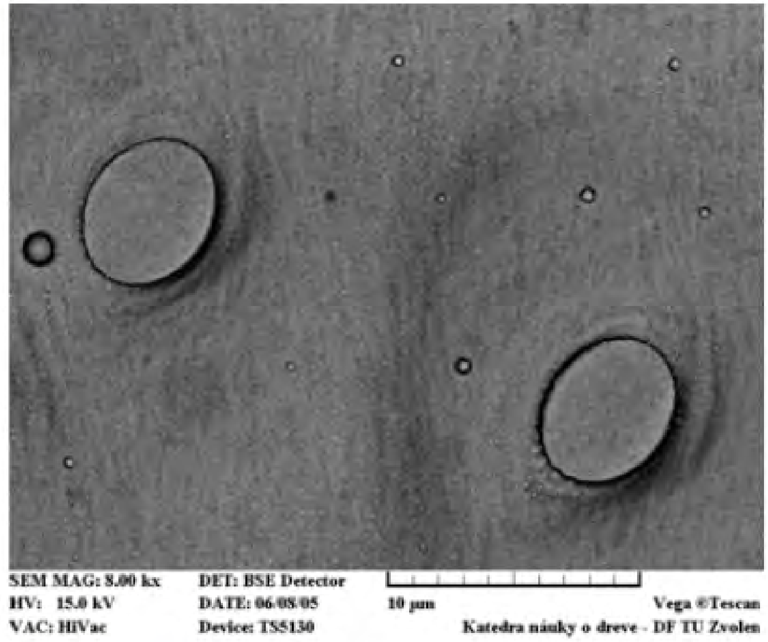


Pure protein-borate structure
a mixture of boric acid (5%) with protein (2.5%)

BSE Detector

Výstup SE-BSE signálov

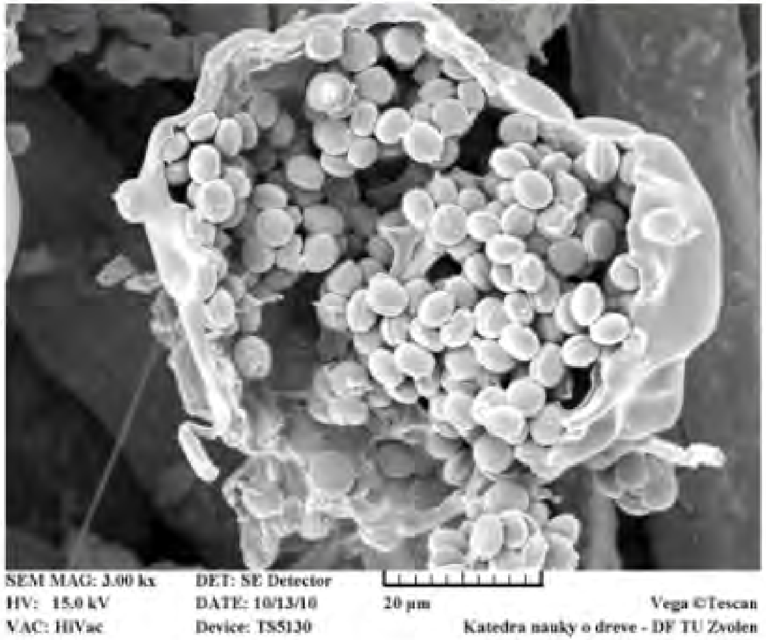


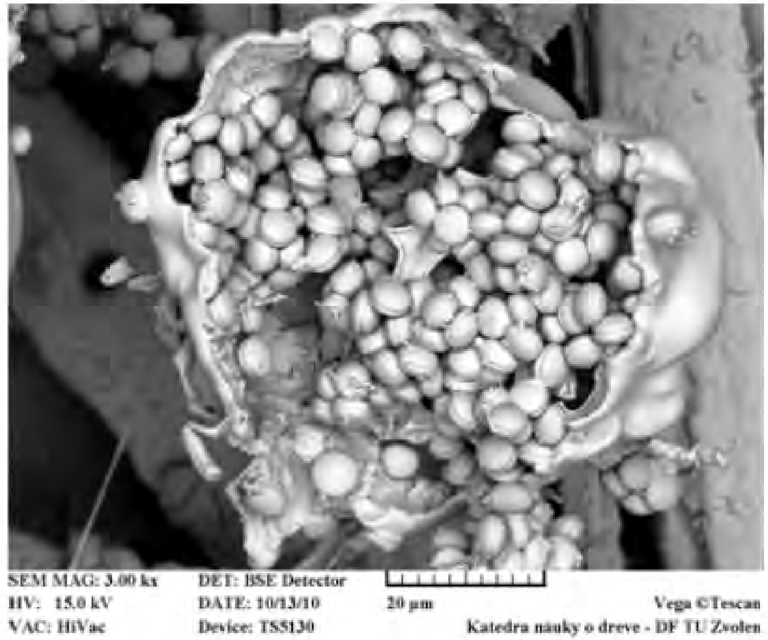


Solutein 1.0% vodný roztok, dvojbodky na radiálnej stene jarnej tracheidy *Pinus sylvestris*

BSE Detector

Výstup SE-BSE signálov

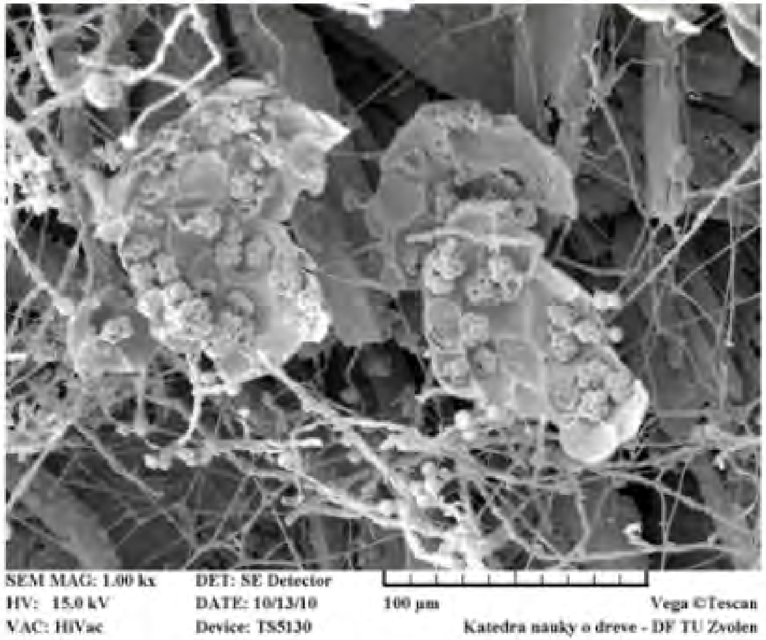




Spóry

BSE Detector

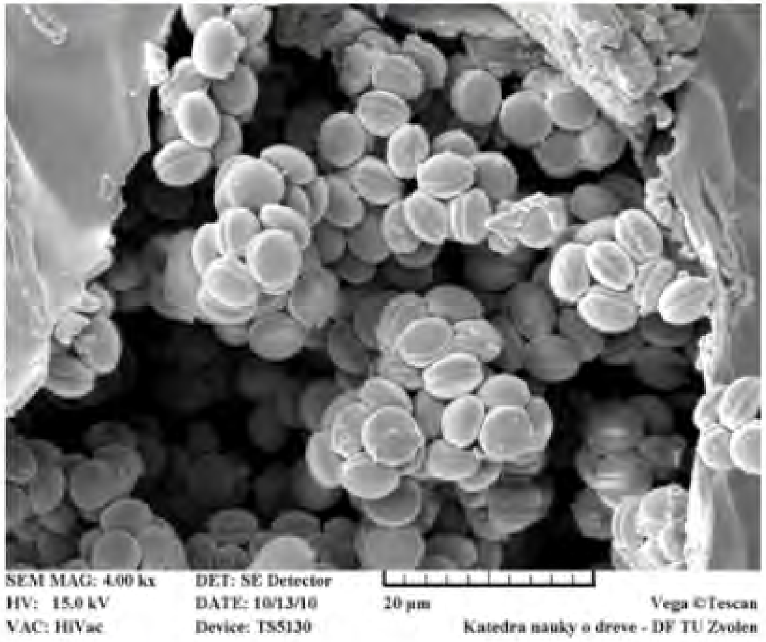
Výstup SE-BSE signálov

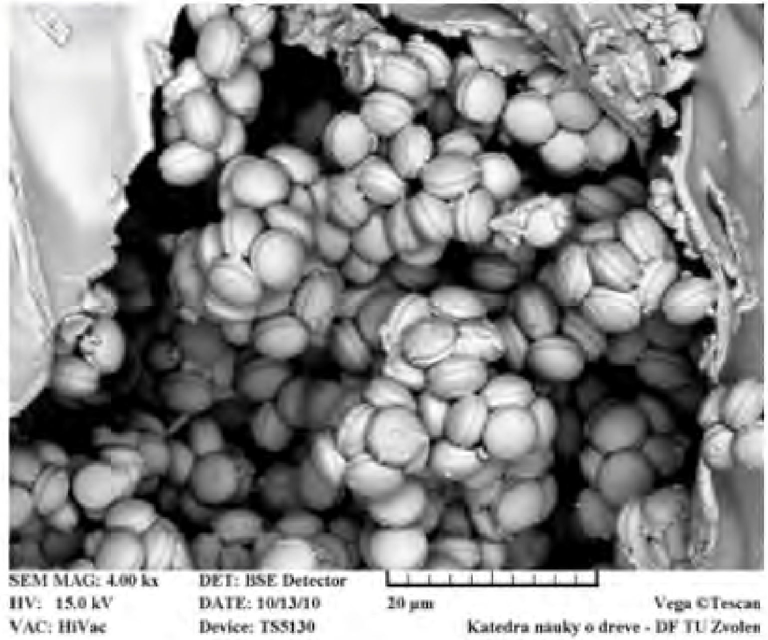


Spóry

BSE Detector

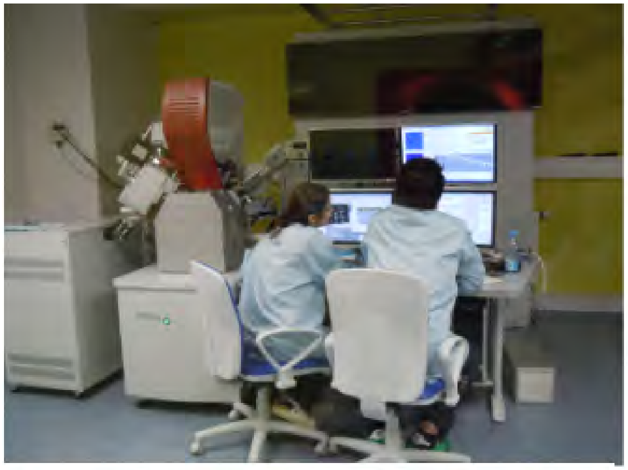
Výstup SE-BSE signálov

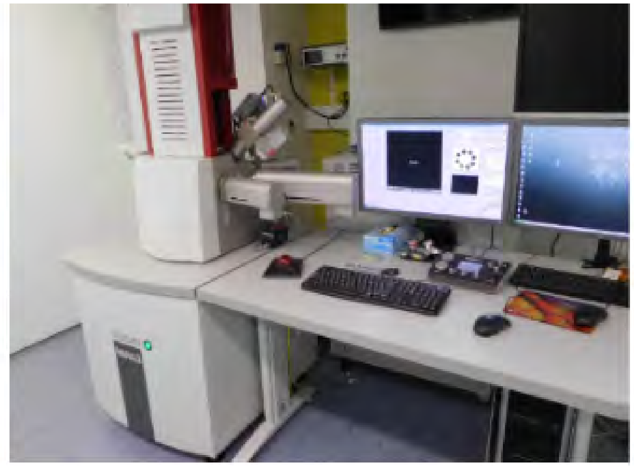




Pollen grains **BSE Detector**

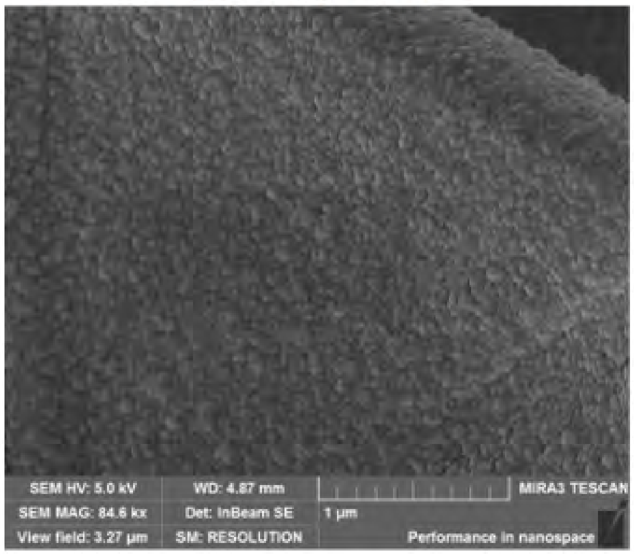
Možná kombinácia BSE+SE – mixed picture

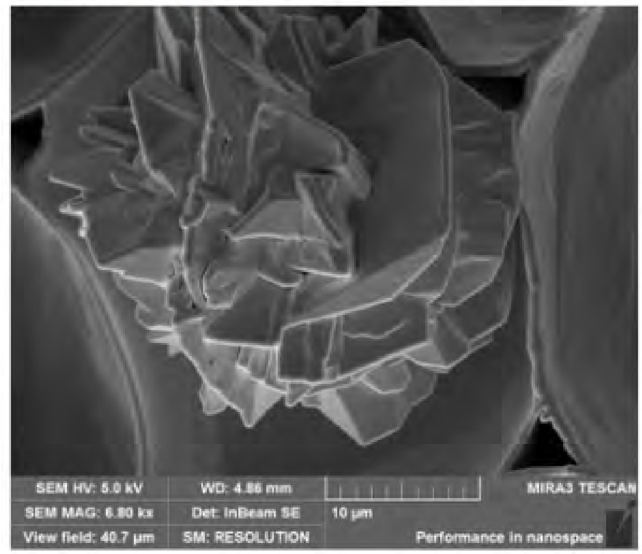




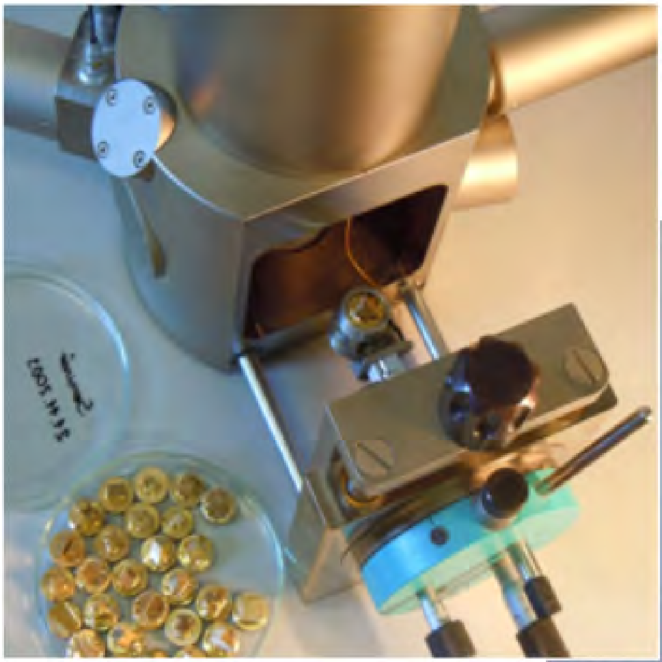
Tescan Orsay Holding, Brno (laboratóriá)

Tescan MIRA, Brno (2.3.2015)





Tescan VEGA TS 5130



Príprava preparátov pre SEM

Preparáty z drevných štruktúr pre SEM je vždy potrebné špecificky pripravovať a to z nasledujúcich dôvodov:

- pre vysokovákuový SEM vzorka **nesmie obsahovať vodu**
- musí byť stabilná pod zväzkom elektrónov
- vzorka by mala byť **elektricky vodivá**, aby sa nenabíjala záporne nabitými elektrónmi
- na povrchu vzorky by nemali byť prítomné **cudzorodé častice a nečistoty**

Každý postup prípravy je **jedinečný** a vyvinutý v závislosti na charakteristike objektu skúmania a požiadavke, aby výsledné snímky preukázali požadovanú informáciu.

Príprava preparátov pre SEM

Príprava preparátu **pre vysoké vákuum** v SEM mikroskope všeobecne zahŕňa nasledujúce kroky:

- **Odber prieskumných sond** (z krovu, trámov, dreveného artefaktu).
- **Vymanipulovanie preparátov** z odobratých sond - príprava **R** a **T** **štiepnych plôch (čepieľkou)**, ktoré budú **následne zrezané žiletkou** a **Pr** rezov; výška vzorky by nemala presiahnuť 5-6 mm.
- Pre degradovaný, ale aj extrémne tvrdý preparát xyléme

  sme navrhli a overili - ***Daucus carota***,

následne ukotvíme do zveráčika a odoberieme žiletkou tenkú vrstvičku z radiálnej (tg) štiepnej plochy pre dosiahnutie ideálneho rezu.

- Každý preparát radiálneho rezu je zrezaný žiletkou taktiež **šikmým priečnym rezom** z dôvodu orientácie v oblasti jarného a letného dreva preparátu

Príprava preparátov z historického dreva pre SEM

Fotookumentácia odobratých sond A preparátov drevených prvkov podľadu NKP Slovenská Ľupča

Detaily vzoriek z hlavy (1) a z misy (2) plastiky Hlava Jána Krstiteľa

Limitne malé vzorky

- potrebné správne sa rozhodnúť aký rez vymanipulujeme
- najvýpovednejšiu hodnotu **pre ihličnaté drevo** má **rez radiálny** (pre listnaté drevo – tangenciálny rez)

Príprava preparátov z historického dreva pre SEM

- **Označenie a fixácia** preparátov pomocou PVAC lepidla k alumíniovým terčíkom

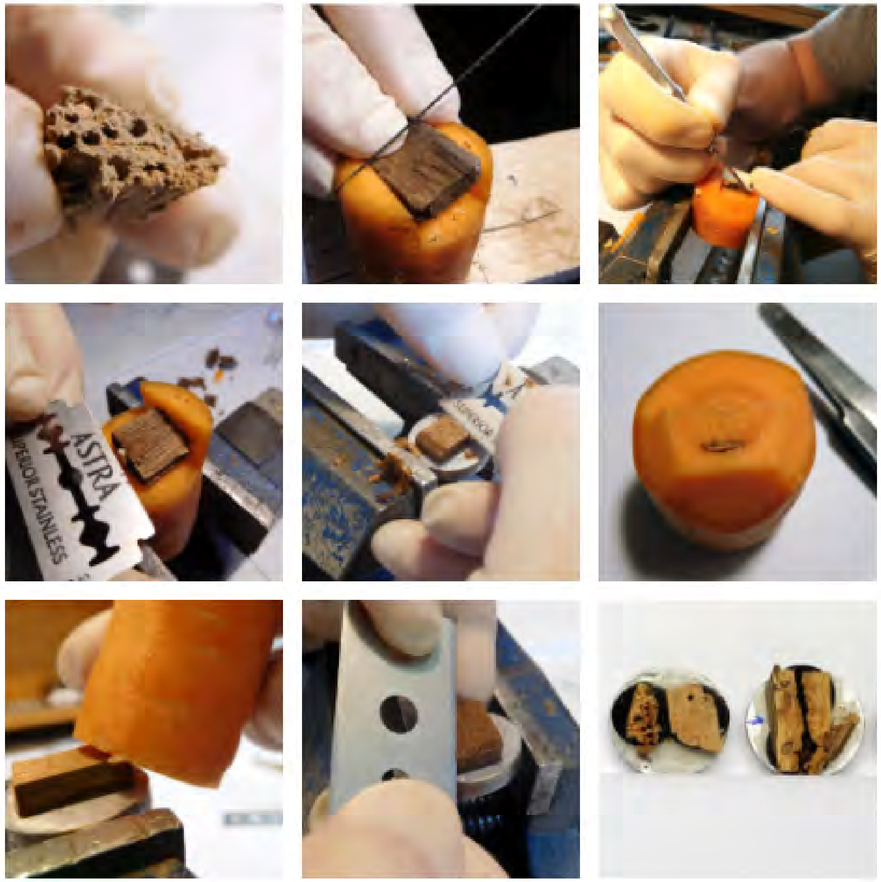
- **Osobitné požiadavky** sú kladené na lepidlo:

- musí vytvoriť vodivý spojovací prvok medzi vzorkou a terčíkom
- nesmie vzniknúť absorpcia do lúmenov kapilár dreva (zamedziť kontaminácii a prekrytiu vnútornej štruktúry);
- nesmie reagovať pri vysokom vákuu pri pozlacovaní

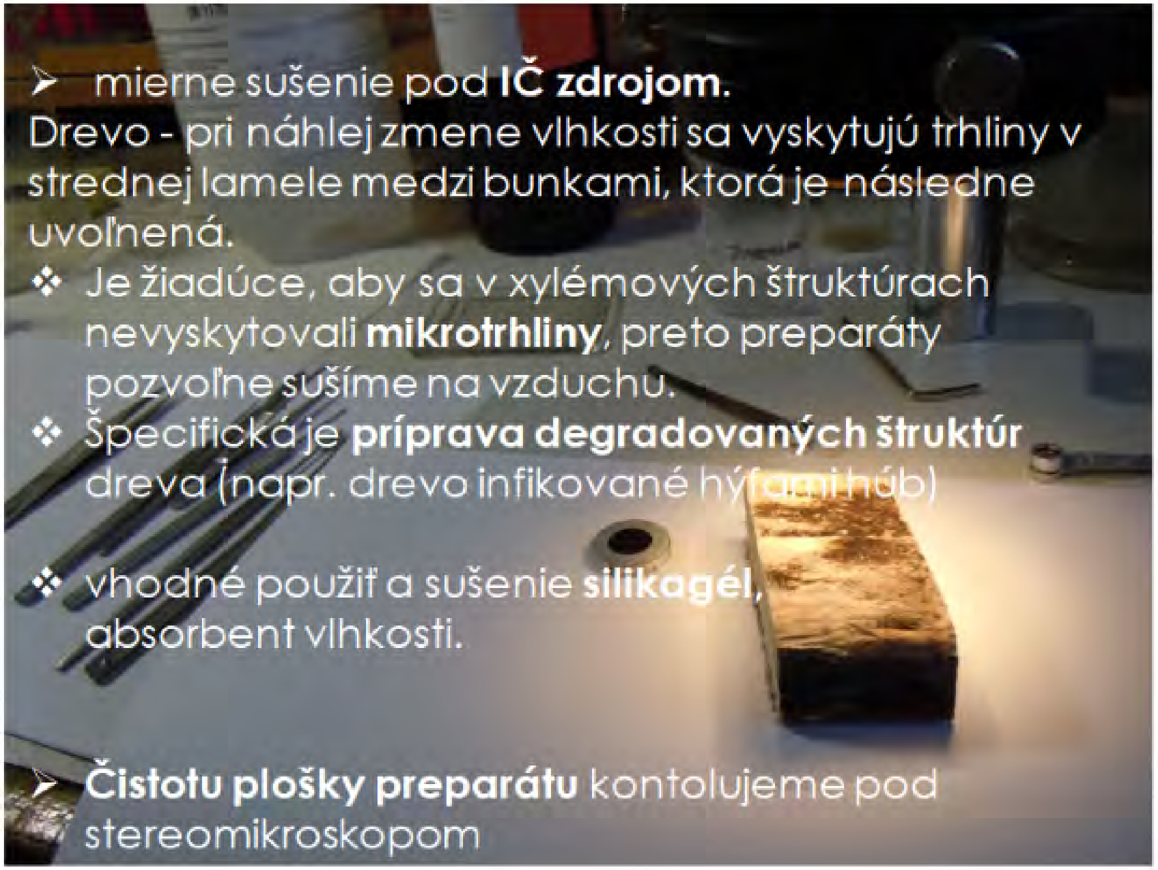
Ideálne riešenie - fixácia priečnych rezov pomocou **uhlíkových samolepivých terčíkov** – zamedzenie penetrácie adhezíva do kapilárnych štruktúr dreva

Pre orientáciu v hĺbke sondy je **vyznačený povrch** radiálnych preparátov šípkou odspodu terčíka.

Príprava preparátov z historického dreva pre SEM



Dehydratácia fixovaného preparátu



- mierne sušenie pod **IČ zdrojom.**

Drevo - pri náhlej zmene vlhkosti sa vyskytujú trhliny v strednej lamele medzi bunkami, ktorá je následne uvoľnená.

- Je žiadúce, aby sa v xylémových štruktúrach nevyskytovali **mikrotrhliny**, preto preparáty pozvoľne sušíme na vzduchu.
- Špecifická je **príprava degradovaných štruktúr** dreva (napr. drevo infikované hýfami húb)
- vhodné použiť a sušenie **silikagél,** absorbent vlhkosti.

- **Čistotu plošky preparátu** kontolujeme pod stereomikroskopom

Príprava preparátov z historického dreva pre SEM

Pre zlepšenie povrchovej vodivosti sa vzorka **pozlacuje 24K zlatom**.
Cieľom pozlacovania je kontinuálne pokrytie vzorky veľmi tenkou vrstvou ktorá je hrubá len niekoľko nm (10-20 nm)

- Materiál, ktorý je dobre tepelne a elektricky vodivý

Preparáty pre skenovaciu elektrónovú mikroskopiu pred a po pozlátení 24K zlatom

Fixácia preparátov pre SEM

- K**ryofikácia** – rýchle zmrazenie je v súčasnosti považované za najlepší spôsob, ako zachovať preparát čo najbližšie natívnemu stavu - **SEM s kryostolíkom**
- **Zmrazenie živých pletív**

v kvapalnom dusíku
(**na teplotu -195.79 °C**)
Unikátne snímky
pre oblasť lesníckej fytológie
priečne lomy RD

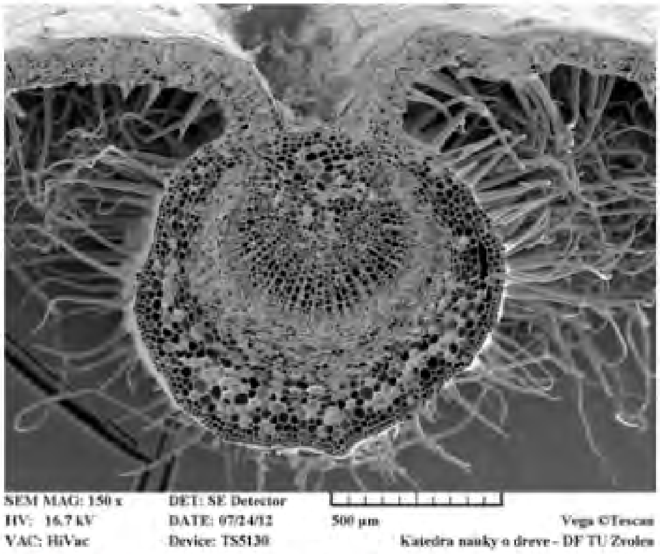
Sušenie preparátov pre SEM

Metódy sušenia preparátov pre SEM:

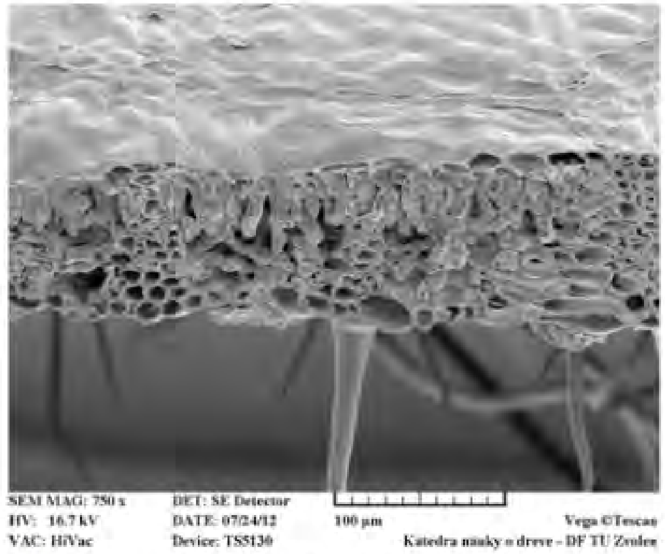
- **Metóda kritického bodu** (CPD) - **Critical Point Drying**
- pri kritickej teplote a tlaku zmiznú rozdiely medzi kvapalnou a plynnou fázou danej látky a čo je podstatné, zmizne aj fázové rozhranie medzi nimi.
- Špeciálna aparatúra - **kvapalný oxid uhličitý**. Hodnota kritického tlaku je **7 390 kPa**, **kritická teplota 31°C**.
- **Freeze drying** –pomalá sublimácia ľadu zo zmrazenej vzorky za zníženého tlaku a pri kontrolovanom zvyšovaní teploty

Sušenie preparátov pre SEM

- **Metóda kritického bodu** (CPD) - **Critical Point Drying**
- Metódu sme overili na biologických preparátoch (list *Ulmus x hollandica*) Riziko- tvarové zmeny mäkkých pletív z dôvodu vysokého tlaku.



Priečny rez hlavnou žilou listu U. 'Dodoens'

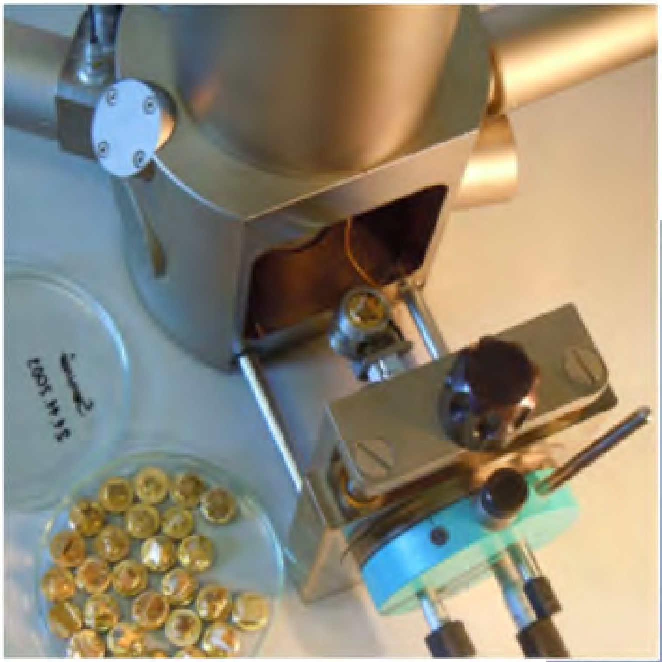


Priečny rez hlavnou žilou listu U. 'Dodoens'

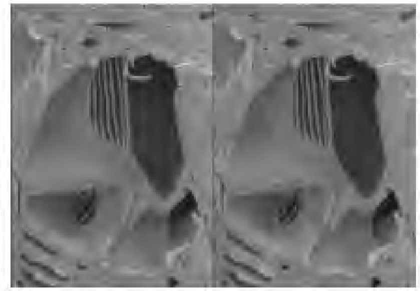
Pokovenie vzoriek

Obr. **Lepenie vzoriek a ich pokovenie**: a) **Sputter Coater POLARON SC7680** - zariadenie na pozlacovanie preparátov **iontovým naprašovaním** v nízkotlakej argónovej atmosfére; b) **Vákuové pokovovovacie zariadenie**; c) obojstranne lepivé uhlíkové vodivé terčíky; d) zlatom pokovené nosné alumíniové terčíky so vzorkami pripravené na pozorovanie

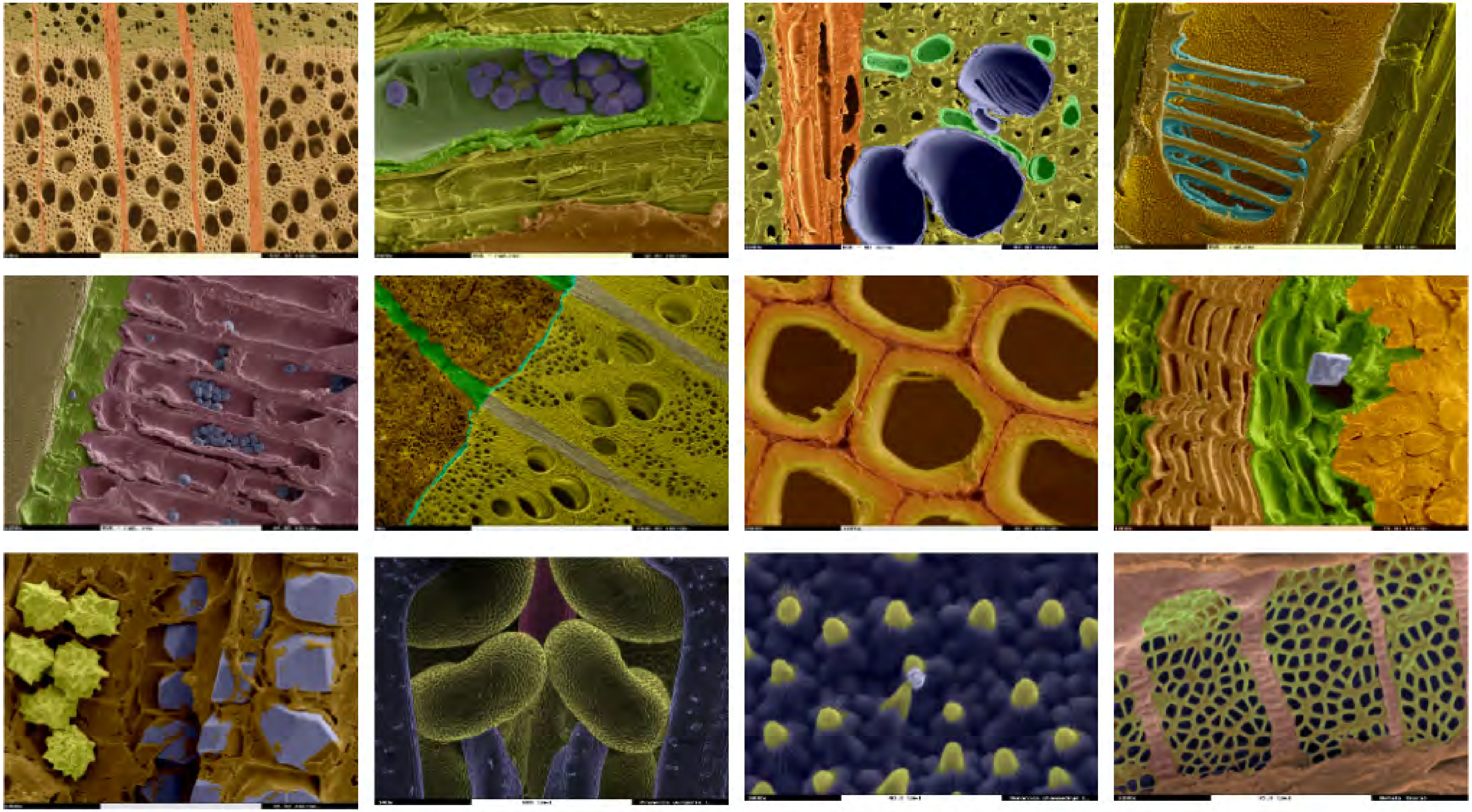
Tescan VEGA
TS 5130



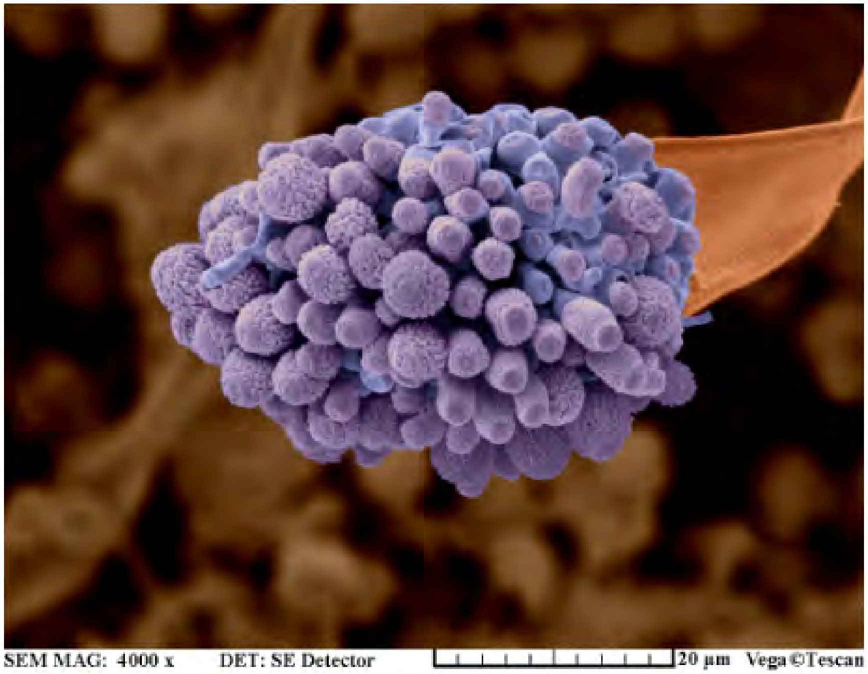
Stereo



Peľnica čiernohlávok obyčajný - *Prunella vulgaris*



40.


SEM MAG: 4000 x
DET: SE Detector
20 µm
Vega ©Tescan


SEM MAG: 4.00 kx
DET: SE Detector
20 µm
Vega ©Tescan

Anatomická diagnostika a determinácia druhu dreva

stenčeniny stien – dvojbodky tracheíd, dvojbodky ciev, typy krížových polí, kvalita pletív, anomálie rastu

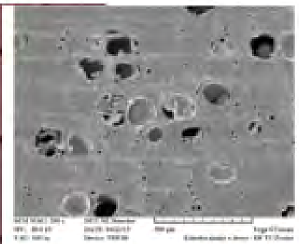
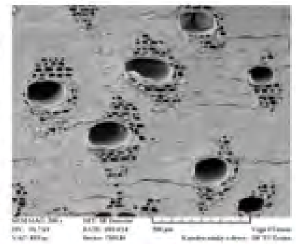
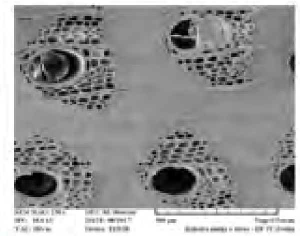
Prieskum poškodenia dreva v historických krovoch

- neskorogotický krov **Kostola sv. Kataríny v Banskej Štiavnici,**
- krov neogotickej **kostolnej veže** v Spišskej Novej Vsi,
- krov Rímskokatolíckeho kostola Všetkých Svätých v Brezovici nad Torysou
- južná veža románsko-gotickej **Katedrály sv. Martina v Spišskej Kapitule**
- Historický krov v **Klášteře premonstrátů v Želivě** (Česká republika)

- **Materiálové prieskumy historických objektov NKP Krásna Hôrka, NKP Slovenská Ľupča**

Štruktúra tropických drevín vystavených expozičným testom – v prirodzených podmienkach a po umelom starnutí v Xenoteste

bangkirai (*Shorea obtusa* Wall.; *Sh.* spp.), **cumaru** (*Dipteryx odorata* (Aubl.) Wild.), **cumaru rosa** (*Dipteryx magnifica* (Ducke) Ducke), ipé (*Tabebuia serratifolia* Nichols.), jatobá (*Hymenaea courbaril* L.), kusia (*Nauclea diderichii* Merill) a **massaranduba** (*Manilkara bidentata* A. Chev.)

- **Databáza anatomických dát** chránených druhov tropického dreva - ***Diospyros spp. a Dalbergia spp.***
- Analýza štruktúry xylému **neivazívneho klonu**
  Paulownia Cotevisa 2

▸V spolupráci s LF TUZVO - Katedrou fytológie

- Štrukrúra dreva a listov vyšľachtených kultivarov ***Ulmus x hollandica***, analýza anatomických parametrov dreva mikropropagovaných jedincov v podmienkach umelo vyvolanej infekcie hubovým patogénom ***Ophiostoma novo-ulmi***

▸V spolupráci s LF TUZVO - Katedrou integrovanej ochrany lesa a krajiny

- Mikroskopická analýza odobratých vzoriek *Fraxinus excelsior* L. infikovaných patogénom ***Chalara fraxinea***

▸Spolupráca so Stredoslovenským múzeom v Banskej Bystrici:

- SEM analýza vzoriek odobratých zo sochy **sv. Františka s bradou**, ev. č. Vu-04391 - Analýza pred konzerváciou sochy.
- Mikroskopická analýza vzoriek drevnej hmoty z plastiky **„Hlava Jána Krstiteľa“** s identifikáciou druhu dreva, ev.č.: Vu-03023

▸V spolupráci s Fakultou stavební VŠB – TU Ostrava -

Katedra Stavebních hmot a diagnostiky staveb

- Hodnotenie **modelovej mineralizácie** dreva pomocou SEM - roztoky organosilánov a kremičitanov, a ošetrenie pentahydrátom síranu meďnatého ($CuSO_4 \cdot 5H_2O$) pre simuláciu mineralizácie v kyslom prostredí
- Materiálové prieskumy historických krovov (Kateřinky, Želiv)

▸V spolupráci s Department of Wood-Based Composites, National University of Forestry and Wood Technology of Ukraine, Lviv :

- Analýza **zhustenej štruktúry** dýhy jelše (*Alnus glutinosa* (L.)Gaertn.) - vplyv krátkodobého termo-mechanického zhustenia na šikmých priečnych a radiálnych rezoch.

▸V spolupráci s Faculty of Wood Technology, Institute of Chemical Wood Technology, Poznań University of Life Science, Poznań, Poland+Italy

- SEM analýza celulózovej buničiny po dvoch a piatich rokoch prirodzeného starnutia - v jazernej vode a rašelinovej pôde - v **archeologickej lokalite Biskupin** - odhadnúť najlepšie podmienky pre obnovu zachovania archeologického dreva in situ

- **Termicky modifikované drevo** jaseňa, buka

- SEM analýza exponovaných povrchovo upravených **šindľov**

na vybraných historických objektoch (Rímskokatolícky kostol sv. Kataríny - Handlová, Augustovský dom - Banská Štiavnica, Vodný mlyn - Kolárovo, Hámor – Medzev)

- **Degradovaný xylém:**

drevo pagaštana konského - hubou ***Fomes fomentarius***,

vnútorná beľ duba zimného degradovaná hubou ***Daedalea quercina* (L.) Fr.**,
drevo buka – cielenou degradáciou eróznou hubou ***Phanerochaete chrysosporium*** a lignin-selectívnou hubou ***Ceriporiopsis subvermispora***

drevo smreka pôsobením mikroskopickej huby ***Trichoderma viride*** a baktérie ***Bacillus subtilis***


DREVÁRSKA FAKULTA
TECHNICKÁ UNIVERZITA VO ZVOLENE
21.–22. SEPTEMBER
2017
MEDZINÁRODNÁ
KONFERENCIA
na tému:
3D MERANIE
A ZOBRAZOVANIE
Elektrónová mikroskopia a štúdium drevných štruktúr
Ing. Miroslava Mamoňová, PhD.
22. 9. 2017
Elektrónová mikroskopia
Nové 3D aplikácie a zobrazenia
Materiálový prieskum historických objektov
2. ročník 3D meranie a zobrazovanie
Zobrazovanie a moderné diagnostické metódy v priemyselnej praxi

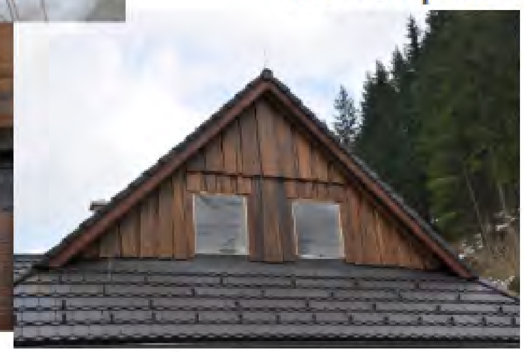

Nové 3D
aplikácie
a zobrazenia
Alicona
MEX
Stenčeniny
CRYO-SEM
FIB-SEM

SEM APLIKAČNÉ ANALÝZY

Zrubový dom v Nižnej Boci.
Stavba realizovaná v máji r. 2013.
Postavený z borovicového a smrekovcového dreva

Alicona MeX softvér

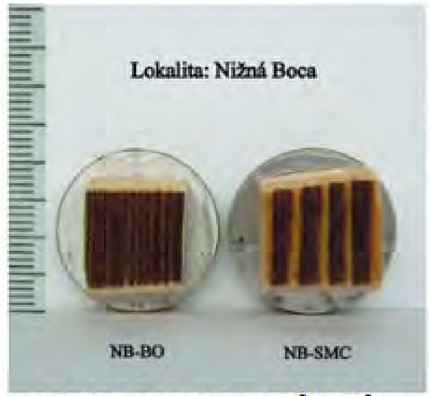
aplikovaný na kartáčovaný povrch sondy
dreveného zrubu,
Nižná Boca – vytvorenie 3D modelu povrchu



Miesta odberu exponovaných vzoriek
z časti prizmy,
zo štítu a čelnej plochy

ALICONA MEX SOFTVÉR

- Následne boli vyhotovené **preparáty** **(NB 1-R, NB 1-T NB 2 a NB 3)** fixované na duralumíniové terčíky



Preparáty exponovaných a referenčných vzoriek pred pozlátením

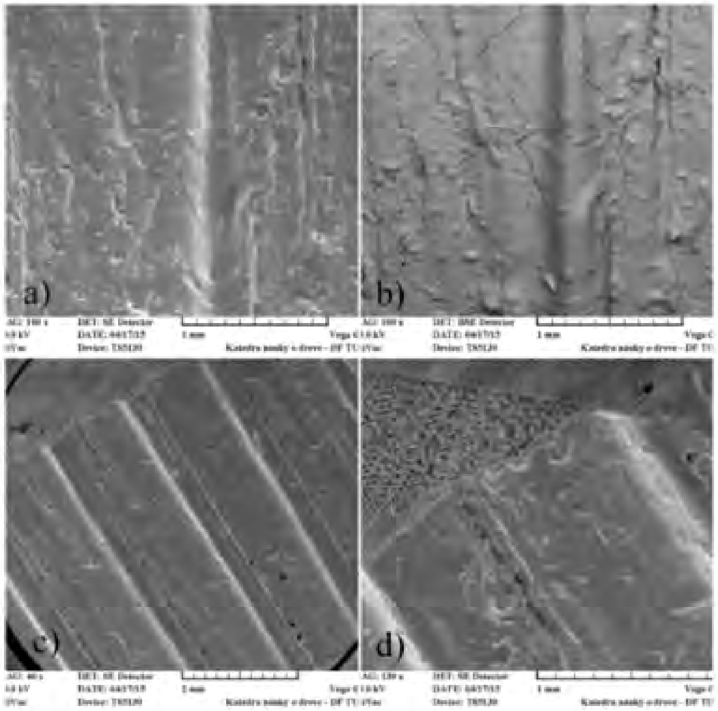
Tab. 1 Použitý náterový systém

Náterová látka	Počet nánosov
Boritá soľ	1x
Tungový olej	1x
OSMO ochranná olejová lazúra	1x
OSMO jednorazová olejová lazúra HS plus (odtieň Eben)	1x (miestami patina)
OSMO UV ochranný olej EXTRA (odtieň bezfarebný)	1x

Mikroskopická analýza exponovanej vzorky NB1-R – kartáčovaný povrch zrubového domu v Nižnej Boci

ALICONA MEX SOFTVÉR

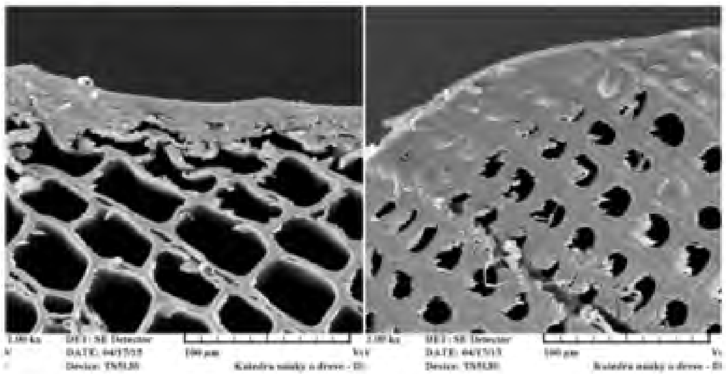
- plastická štruktúra spôsobená kartáčovaním
- trhliny v nátere



c) zvlnený povrch,
d) trhliny na rozhraní jarného a letného dreva, prepady do štruktúry dreva nad živicovým kanálikom,
b) **detekcia trhlín v nátere pomocou BSE detektora**, pričom metodika skenovania morfológie trhlín (fraktografické vyobrazenie) pomocou BSE detektora bola takto použitá unikátne v nátere na povrchu dreva po prvý raz

ALICONA MEX SOFTVÉR

- **Mikroskopická analýza priečneho rezu exponovanej vzorky NB1-R (vľavo: jarné tracheidy, vpravo: letné tracheidy)**

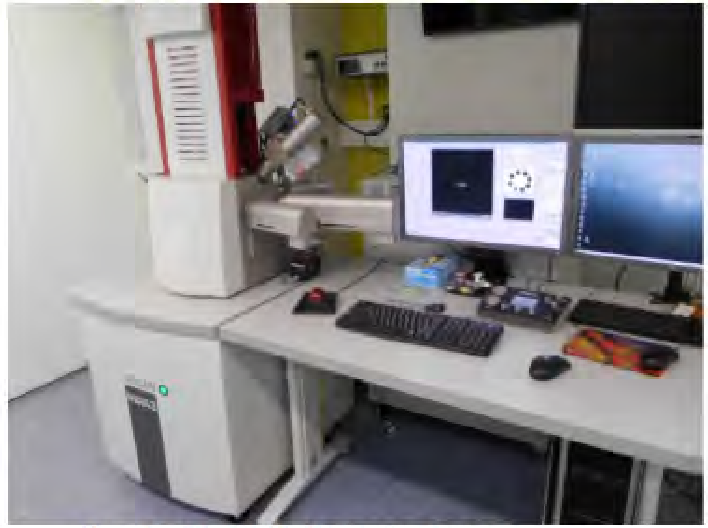


Oblasť JD - náter nepenetruje do dreva, ale je priľnavý k povrchu, vrstva povrchových jarných tracheíd je zdeformovaná kartáčovaním

Oblasť LD - náter penetruje do hĺbky 2 – 3 lúmenov trachíd, je hladký a neodlupuje sa

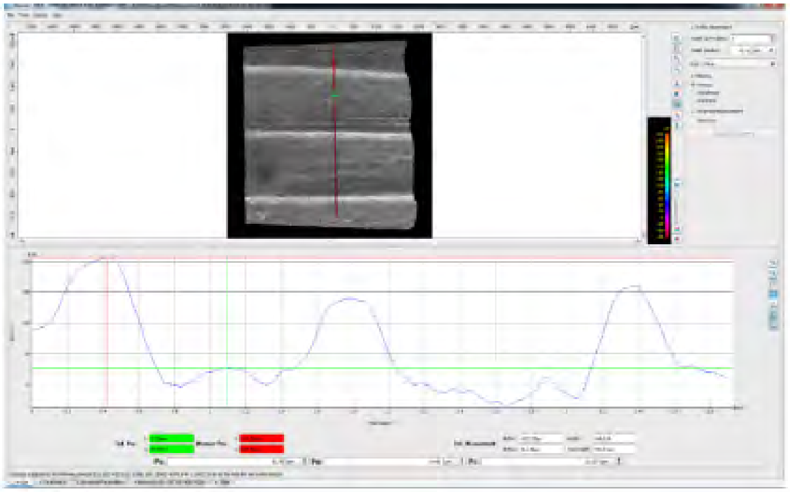
ALICONA MEX SOFTVÉR

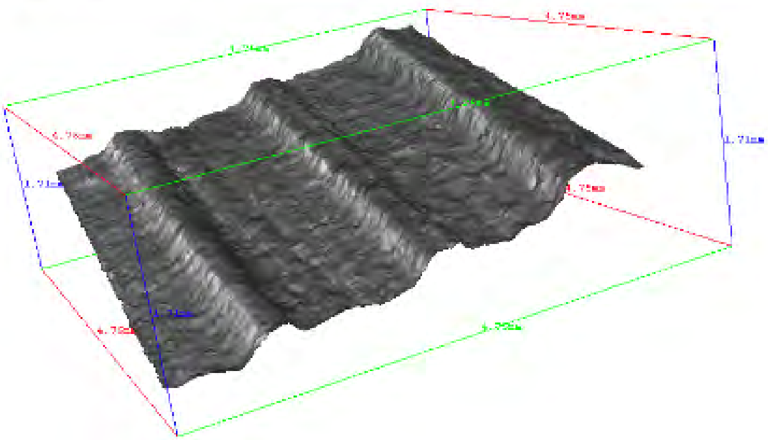
- **3D rekonštrukcia povrchu vzorky**
- Pomocou softvérového modulu **Mex** sme získali DEM (Digital Elevation Model)
- MeX + analytické nástroje: 3D merania: nerovnosť, vlnitosť, profilová alebo objemová analýza
- + jednouché a rýchle ovládanie, stereoskopický obraz SEM, Live 3D skenovanie, videosekvencie a generovanie obrazových sérií

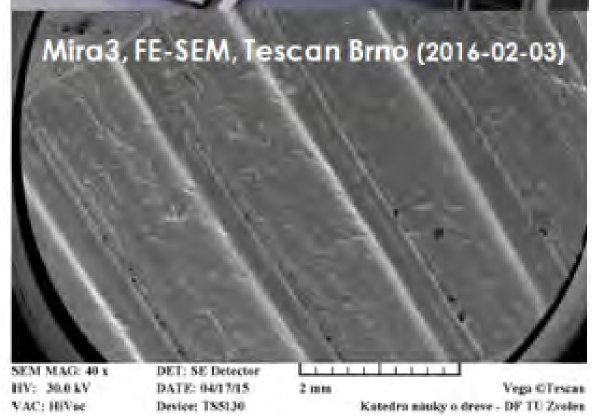


Mira3, FE-SEM, Tescan Brno (2016-02-03)

ALICONA MEX SOFTVÉR





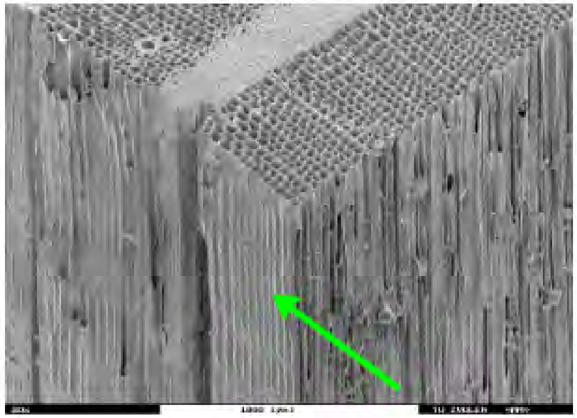


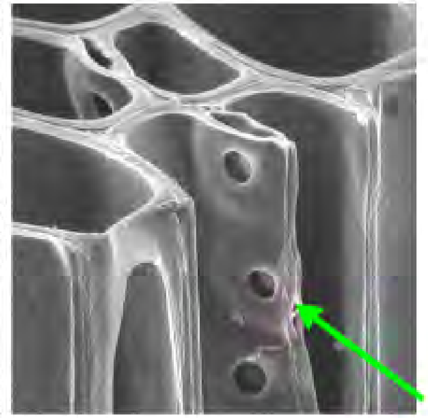
3D model rekonštrukcie kartáčovaného povrchu sondy dreveného zrubu, Nižná Boca

STENČENINY

- **Stenčeniny bunkových stien tracheíd ihličnatého dreva**

3D štruktúra ihličnatého dreva smrekovca (*Larix decidua* Mill.) Usporiadanie dvojbodiek na radiálnych stenách tracheíd





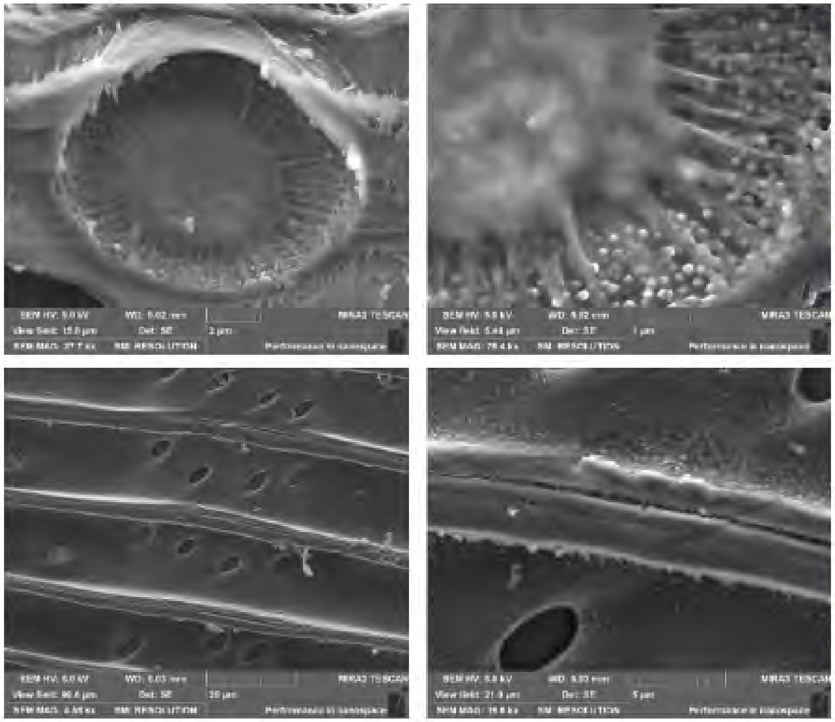
- na radiálnych stenách tracheíd
- pohyb tekutín v dreve v axiálnom a tg anatomickom smere
- intertracheidálne dvojbodky

 torus - ukotvený na lúčovitej priepustnej blanke celulózových fibríl, nazývaných **margo**

➢ Pochopenie **transportných procesov v dreve**,
 procesy **sušenia** dreva, **difúzia** vody v dreve,
 impregnácia a penetrácia látok do dreva

- Stenčeniny bunkových stien tracheíd ihličnatého dreva

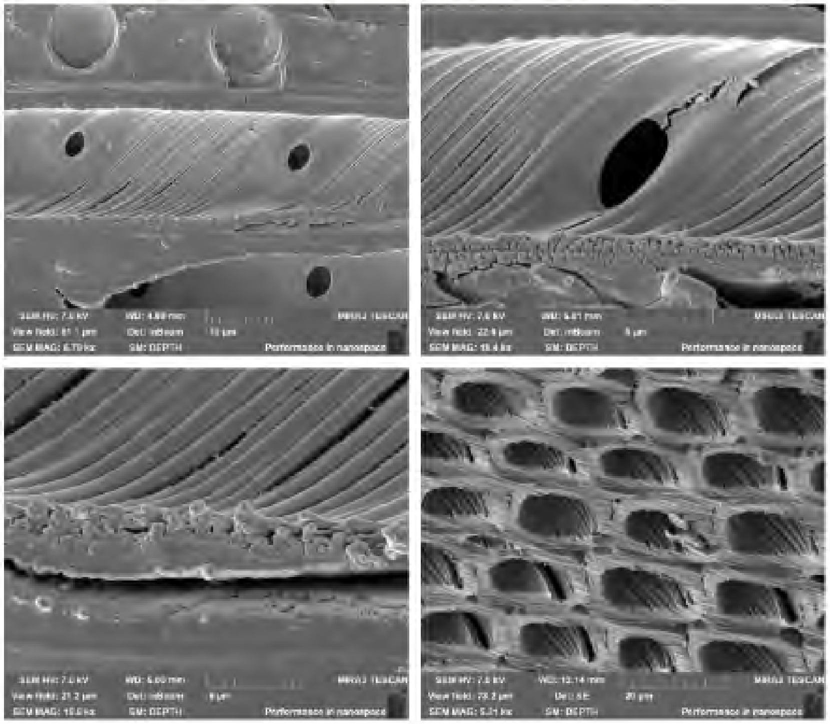
STENČENINY



Stenčeniny tracheidy jedle srienistej (*Abies concolor* (Gordon) Lindl. ex Hildebr.)
a, b) dvojbodka s bradavičnatým vnútorným povrchom (tzv. warty layer);
c, d) jednoduché stenčeniny v taxodioidnom krížovom poli

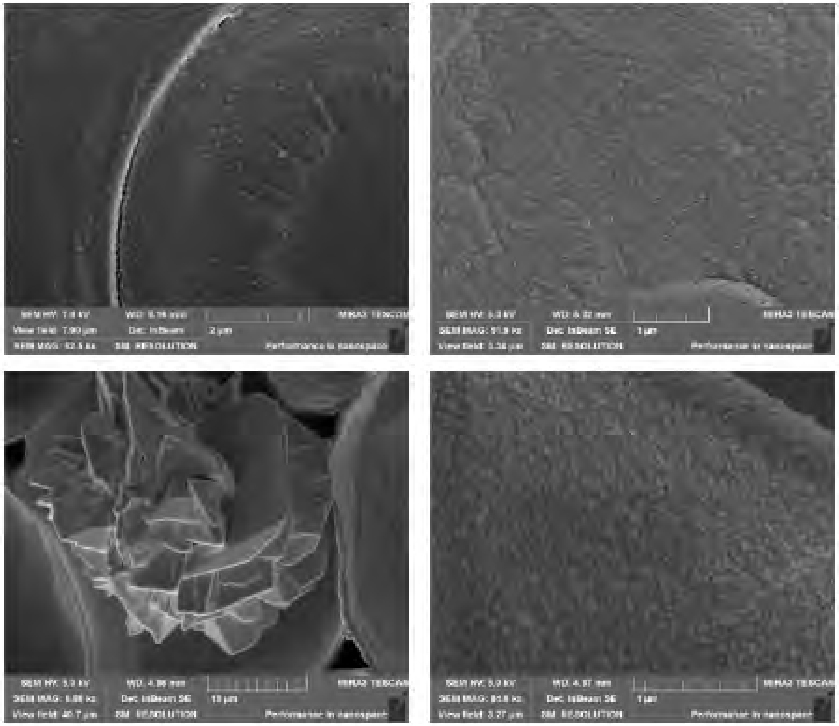
- **Stenčeniny bunkových stien tracheíd ihličnatého dreva**

STENČENINY



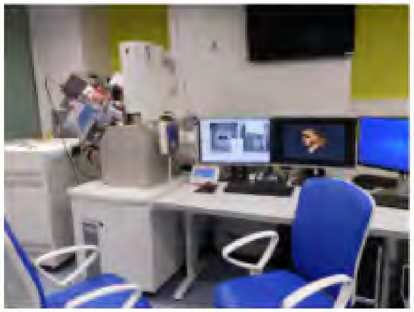
Stenčeniny tracheidy borovice lesnej (*Pinus sylvestris* L.)
a, b) dvojbodka v tracheide reakčného (tlakového) dreva; c) šikmý priebeh fibríl v sekundárnej stene tracheidy reakčného dreva; d) priečny rez tlakovými tracheidami

STENČENINY



Formovanie granúl zlata pokovených preparátov xylému môže zastrieť jemné finesy ultraštrktúry
a) bradavičnatá vrstva komory dvojbodky borovice zastretá granuláciou zlata pri pokovení preparátu, zv. 52 500x;
b) povrch kryštálu šťavelanu vápenatého zastretý granuláciou zlata, zv. 51 900x;
c) kryštalická drúza šťavelanu vápenatého v parenchýme;
d) detail povrchu (c) pokovený zlatom, zv. 84 600x

- **Cryo LOMY - Reakčné drevo buka**

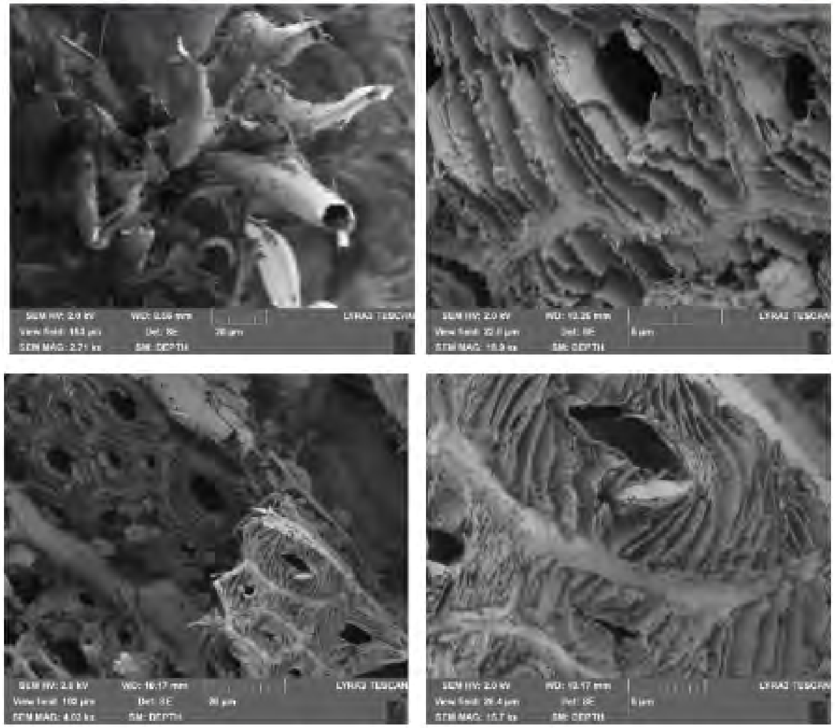


SEM Tescan Lyra3

Naprašovacie zariadenie Leica EM ACE600 (a, b) naprašuje veľmi tenké, jemne zrnité a vodivé kovové a uhlíkové povlaky pre analýzy s vysokým rozlíšením - **pre aplikácie FE-SEM. Systém vákuového prenosu Leica EM VCT500 (b, c) implementovaný k naprašovaciemu zariadeniu Leica EM ACE600 pre prípravu vzoriek Cryo SEM bez kontaminácie;**

CRYO SEM

- Cryo LOMY - Reakčné drevo buka, SEM Tescan Lyra3



Cryo SEM zobrazenie priečnych lomov zónou ťahových libriformných vlákien buka (*Fagus sylvatica* L.)

Zreteľná lamelárna štruktúra bola týmto spôsobom pozorovaná unikátne prvý raz.

CRYO SEM

- **Mikroskopické Cryo-SEM analýzy na Tescan Vega na TU vo Zvolene**

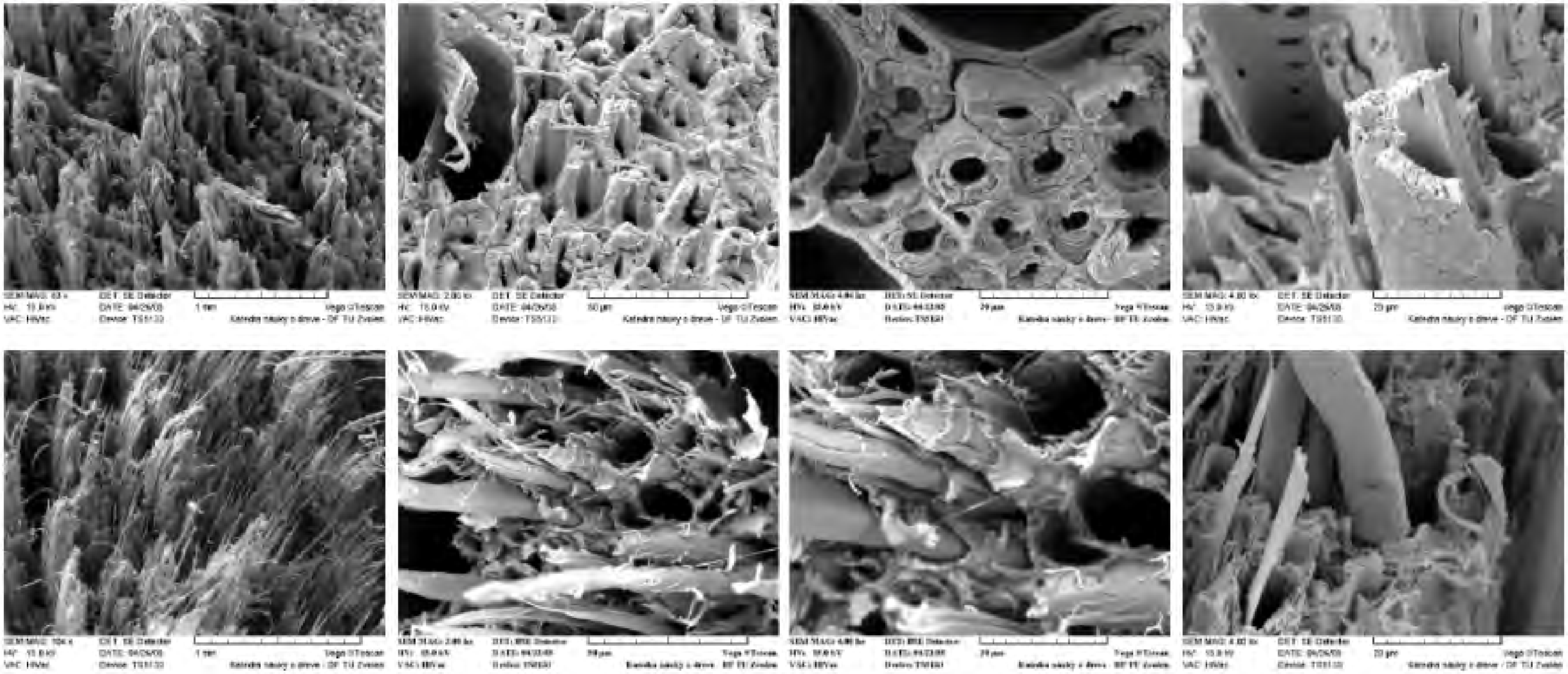
  - na vzorkách bukového dreva, s anomáliou rastu – tvorbou reakčného dreva (**tension beech wood**) a neboli doposiaľ publikované

    - Vzorky malých rozmerov - termonádobe **s kvapalným dusíkom** zmrazené – do úplného nasýtenia kapilárnych priestorov
    - (**na teplotu -195.79 °C**)
    - Prípravok, na ktorom bol uskutočnený v strede telesa lom
    - Lomové plochy sa fixovali na terčík a pozlátili

Kryogénne postupy boli pri príprave preparátov aplikované na xylém unikátne prvý raz.

- Cryo LOMY - Reakčné drevo buka, SEM Tescan Vega

CRYO SEM



Cryo-SEM analýzy v kvapalnom dusíku (-195,79 °C) na Tescan Vega, TU vo Zvolene

- lomové plochy bukového dreva, s anomáliou rastu – tvorbou G vrstvy reakčného dreva buka (tension beech wood)

- **Dual beam FIB-SEM**

(Focused ion beam scanning electron microscopy)

systém aplikovaný **na libriformné vlákno a parenchymatické bunky stržňového lúča buka** (*Fagus sylvatica* L.),

skenované pomocou Tescan LYRA3

FIB-SEM

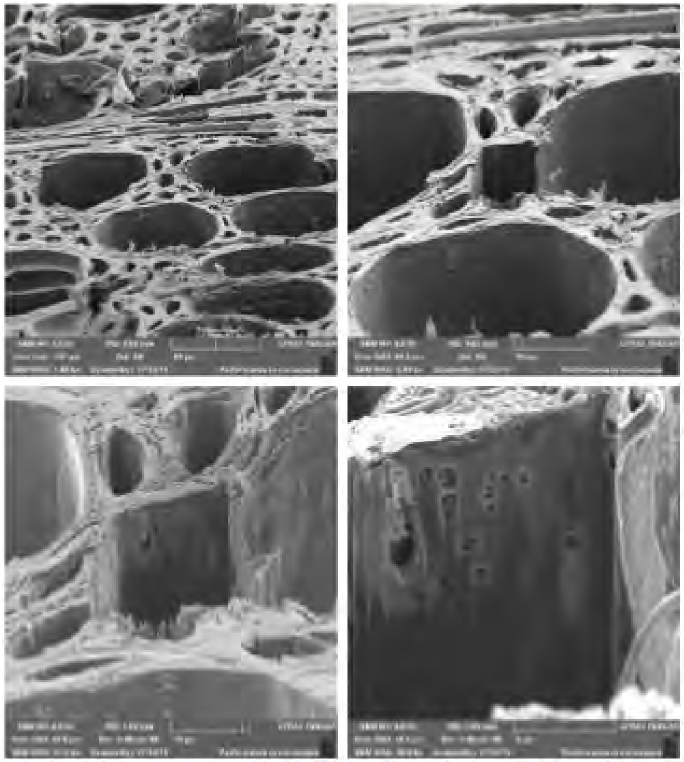
TESCAN FIB-SEM vybavený ión-optikou s vysoko stabilným Ga+ LMIS zdrojom (Cobra column), pričom pri nano-obrábaní sa dosahuje

rozlíšenie 2,5 nm/5 nm.

Parametre rezania: frézovanie /milling : 10 nA, leštenie /polishing : 200 pA

Dual beam FIB-SEM Tescan LYRA3

FIB-SEM

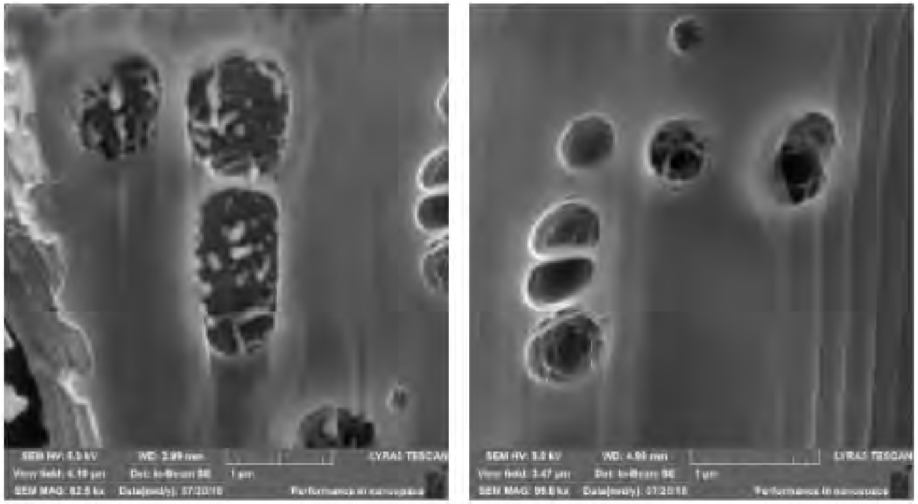


Prerezané stenčeniny v bunkovej stene libriformného vlákna buka (*Fagus sylvatica* L.)
referenčná vzorka reakčného dreva (ref. I6 Ra) pred termickou úpravou

a) Pohľad na priečny rez preparátu buka pred FIB, b) Lokalizácia FIB-rezaného libriformného vlákna, c,d) detailné priestorové zobrazenie stenčenín v bunkovej stene vlákna, FIB-SEM

Dual beam FIB-SEM Tescan LYRA3

FIB-SEM

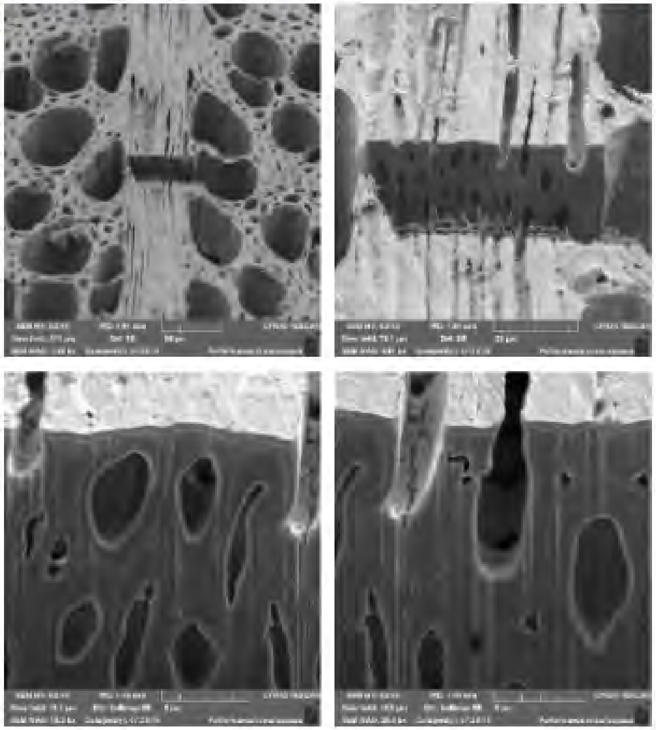


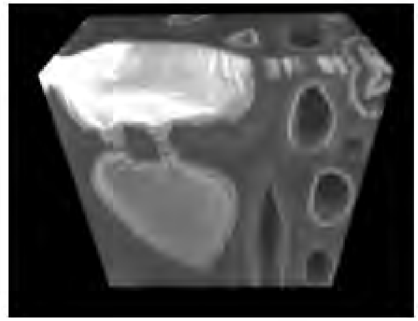
Prerezané stenčeniny v bunkovej stene libriformného vlákna buka (*Fagus sylvatica* L.)
referenčná vzorka reakčného dreva (ref. I6 Ra) pred termickou úpravou

e,f) detailné priestorové zobrazenie mikrostenčenín v štruktúre sekundárnej steny vlákna, FIB-SEM

Dual beam FIB-SEM Tescan LYRA3

FIB-SEM





3D focused ion beam tomography of wood sample

Dual beam FIB-SEM system aplikovaný na parenchymatické bunky stržňového lúča buka (*Fagus sylvatica* L.)
a) Lokalizácia rezaného stržňového lúča, b) Prierez parenchýmu viacradového stržňového lúča, c, d) detaily priečne rezaných parenchymatických buniek – pozoruhodné mikropriestory v kontakte parenchýmu v oblasti strednej lamely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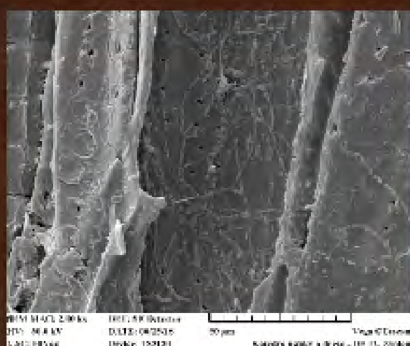
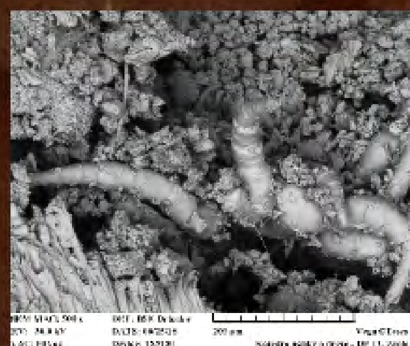
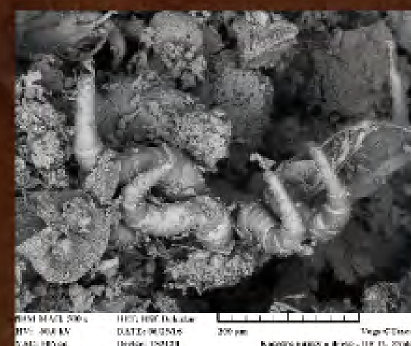
Materiálový prieskum historických objektov
NKP Krásna Hôrka
NKP Slovenská Ľupča
Klášter v Želivě
Poďakovanie

Materiálový prieskum drevených prvkov konštrukcií NKP Krásna Hôrka

Odberné miesto č. 1 - Dolný Hrad – Schody do podkrovia
Vzorka č. 1 (9. stupnica)



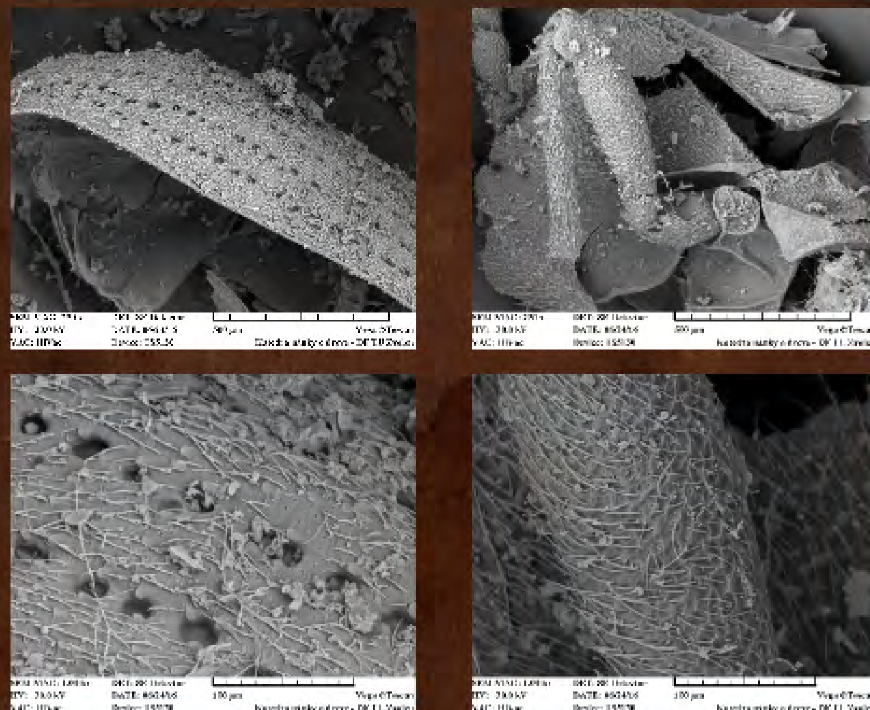




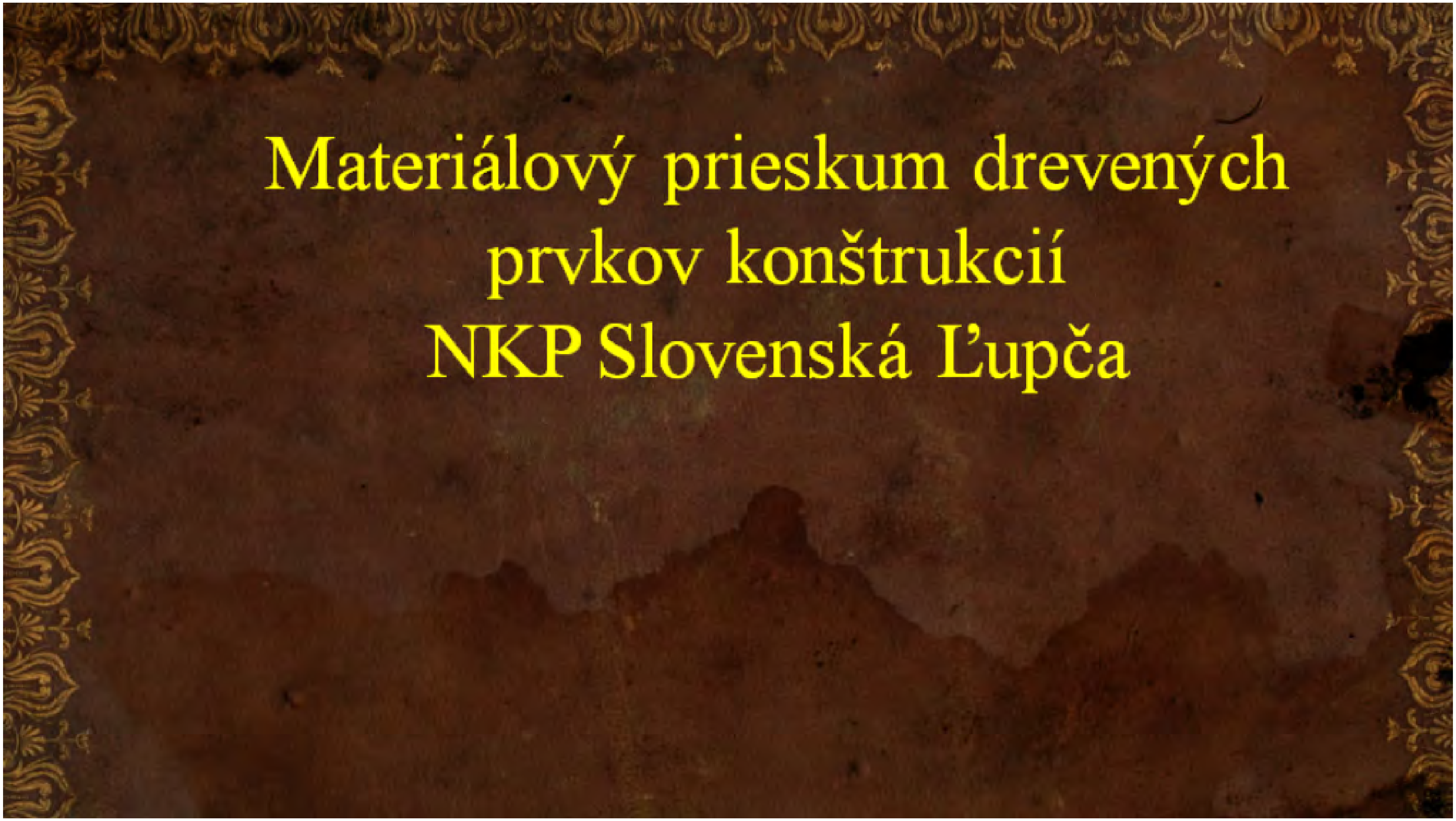
Diagnostikovaný sklerotizovaný roztoč prachový (Dermatophagoides pteronyssinus Tr.), veľký 0,2-0,7 mm

Anobium punctatum

Črvotoč bodkovaný (*Anobium punctatum* De Geer) - nález dospelca (imágo) črvotoča. Femur imága črvotoča bodkovaného (*Anobium punctatum* De Geer) porastený ochlpením, krovky charakteristicky pokryté líniami okrúhlastých priehlbín, pokryté jemným ochlpením.



73.


Materiálový prieskum drevených
prvkov konštrukcií
NKP Slovenská Ľupča

NKP Slovenská Ľupča

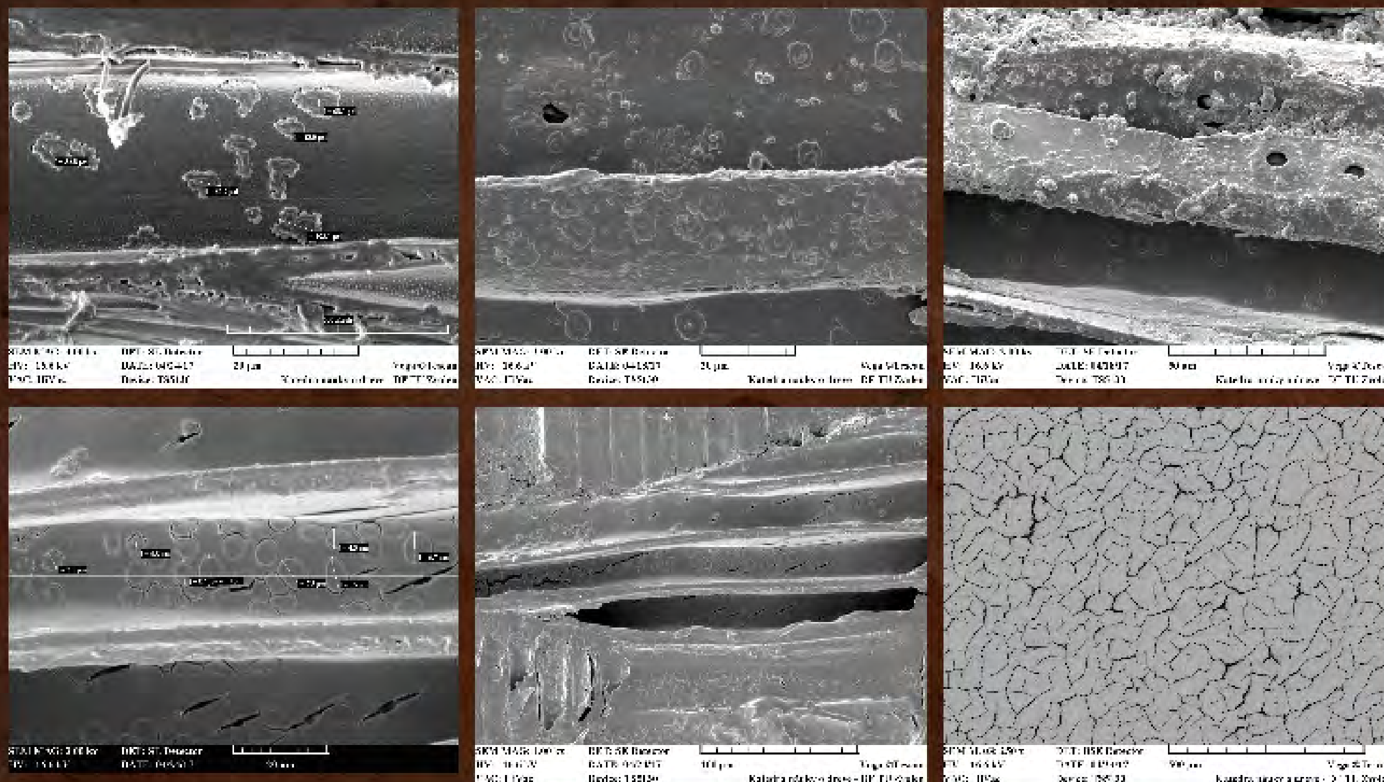
Je to jeden z mála hradov na Slovensku, ktorý je nepretržite obývaný od stredoveku až po súčasnosť.

Najstaršia písomná zmienka o hrade pochádza z roku 1250. Hrad postavili krátko po tatárskom vpáde.

Vďaka dobrej polohe v minulosti spoľahlivo strážil starú cestu údolím Hrona vedúcu zo Zvolena do Brezna a ďalej na Spiš.

Dnes hrad spravuje nový majiteľ (Železiarne Podbrezová Group), ktorý vedie rozsiahlu rekonštrukciu na záchranu tejto NKP.

Odberné miesto č. 8 – XIII. trám
Vzorka č. 6 Nerenovovaný trám porovnaný s referenciou



Materiálový průzkum krovových konstrukcí v Klášteře premonstrátů v Želivě

Prof. Ing. Ladislav Reinprecht, CSc., KMTD TU Zvolen
Ing. Jana Daňková, PhD., Fakulta stavební VŠB TU Ostrava
Katedra Stavebních hmot a hornického stavitelství

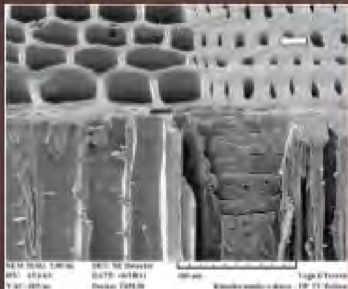
Výzkumný výjezd č.2 - klášterní komplex Želiv

Súčasnosť premonstrátskeho kláštora v Želivě

Areál kláštora v Želivě bol prehlásený za národnú kultúrnu pamiatku v roku 2010.

V r. 1991 bol areál kláštora navrátený premonštrátom. V súčasnosti prebieha postupná obnova kláštorného areálu, ktorej základnou koncepciou je rehabilitácia funkcií všetkých objektov.

Nárožná krokva SZ traktu Prelatury



Obr. 6.1 Vysoký podiel letného dreva, šesťuholníkový prierez letných tracheid - *Larix decidua* Mill.

Obr. 6.2 Bisériové usporiadanie dvojbodiek v jarných tracheidách. *Larix decidua* Mill.

Krov konventu

Obr. 8.9 Ruptúra v bunkovej stene jarnej tracheidy (P3)

Obr. 8.10 Detail – erózia S3 bunkovej steny, vypadnutý torus, vplyvom enzymatickej činnosti (P6)

Krov konventu

Poďakovanie

Táto práca vznikla predovšetkým vďaka zanieteniu pani **Ing. Jany Havránkovej** a **Ing. Kristíny Rosíkovej,** ktoré mi boli nesmierne nápomocné pri aplikačných prácach a metódach, spoločnosti **Tescan Orsay Holding, a.s. Brno**

Moje poďakovanie patrí Oddeleniu špeciálnej meracej techniky, spoločnosti **Kvant, s.r.o. Bratislava**, za všestrannú podporu a pomoc.

This work was funded by the following subjects: the Scientific Grant Agency of the Ministry of Education SR and the Slovak Academy of Sciences (Grant No. 1/0822/17 "Surface modification of wood and coating materials in order to improve stability of the wood – coating material system."). This paper has been included into the project APVV-16-0177 "Progressive modifications of the wood surface, film-forming materials and their interactions at the phase interface."


DREVÁRSKA FAKULTA
TECHNICKÁ UNIVERZITA VO ZVOLENE
21.–22. SEPTEMBER
2017
MEDZINÁRODNÁ
KONFERENCIA
na tému:
3D MERANIE
A ZOBRAZOVANIE
Elektrónová mikroskopia
a štúdium drevných
štruktúr
Ing. Miroslava Mamoňová, PhD.
22. 9. 2017
Elektrónová
mikroskopia
Nové 3D
aplikácie
a zobrazenia
Materiálový
prieskum
historických
objektov
2. ročník 3D meranie a zobrazovanie
Zobrazovanie a moderné diagnostické metódy v priemyselnej praxi

82.

APPLICATIONS OF CONTACTLESS MEASUREMENT SYSTEMS IN THE AUTONOMOUS MOBILITY

Prof. Branislav Sitár, DrSc [1]
[1] FMFI UK, Bratislava

Abstract

Universal Autonomous Transport Systems (ATS) with highly organized transport including hundreds of electric Autonomos Guided Vehicles (AGV) working round the clock could be built in large areas. The world development of AGVs can be divided in two basic categories: a) global: individual AGVs moving alongside with the existing traffic. The basic feature of category a) is the effort to replace the human eye by technology, attaching LiDARs, optical cameras and radars to standard vehicles and operating AGVs on ordinary carriageways.

Category b) - local: Autonomous traffic systems. Their characteristic feature is the use of driverless cars only, involving total exclusion of human drivers from a delimited space, which will lead towards increased order in traffic and towards a substantial reduction in the number of accidents. European patent by B. Sitar introduced a "computer friendly" technology "i-cars on i-road" with a very low imput data flow. The tests show, that our AGV navigation system could provide 10 times higer precision, be 10 times faster and 10 times cheaper, than AGV navigation systems based on other technologies.

The implementation of Autonomous Transport Systems brings a number of social, ecologic and economic benefits. The consortium of the top Slovak universities and innovative companies has prepared an industrial-technology platform, with the aim to produce ATS systems for industrial zones, airports, recreation resorts, exhibition grounds, as well as in the new eco-cities worldwide.

AUTONOMOUS TRANSPORT SYSTEMS

KVANT®

Autonómny Transportný Systém

Prof. Branislav Sitár, DrSc. FMFI, Univerzita Komenského, Bratislava

Kvant
22.9.2017, Bratislava

Svetový vývoj autonómnych vozidiel

možno rozdeliť do dvoch kategórií:

Globálne riešenie

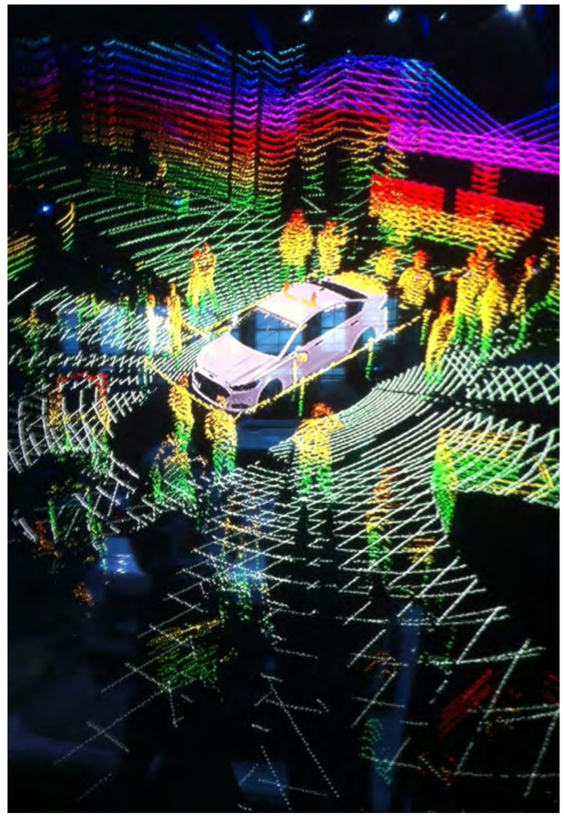
Individuálne autonómne vozidlá (AGV) pohybujúce sa na existujúcich cestách spolu s vozidlami riadenými ľuďmi

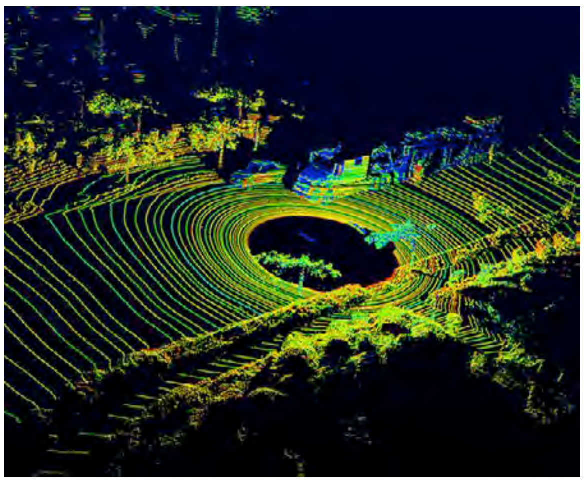
Lokálne riešenie:

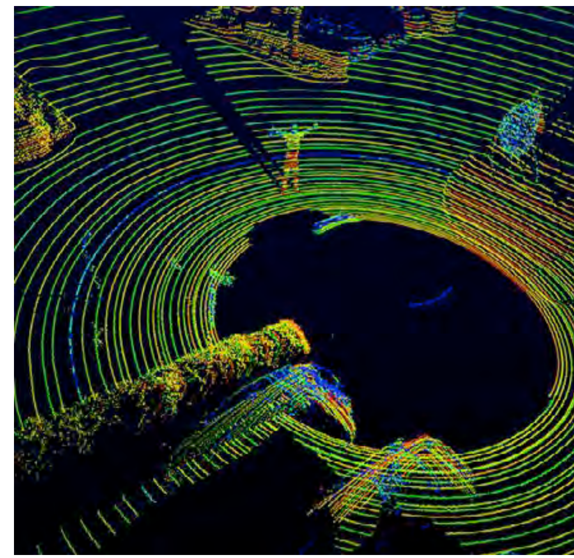
Autonómne transportné systémy v ohraničenom území

A. Individuálne autonómne vozidlá pohybujúce sa na cestách spolu s vozidlami riadenými ľuďmi

Technológia LiDAR scanning

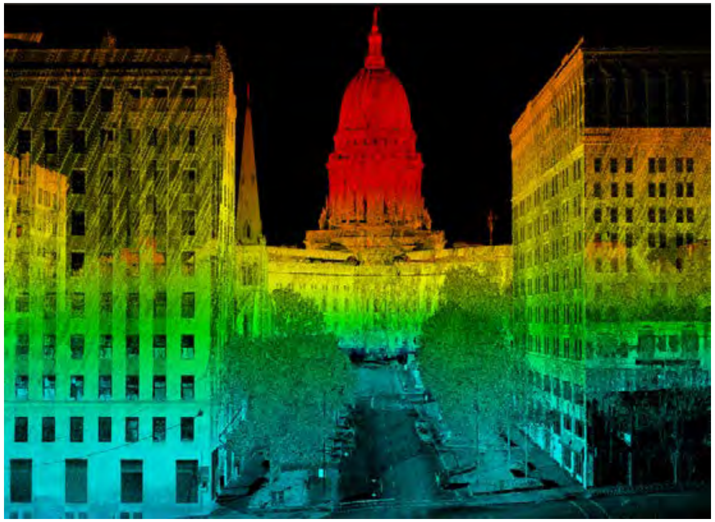




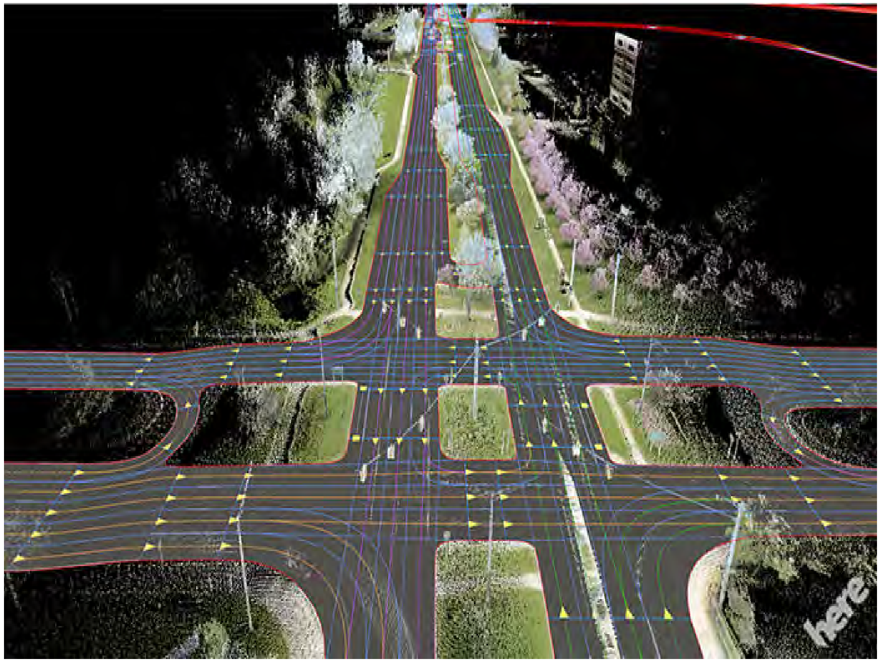


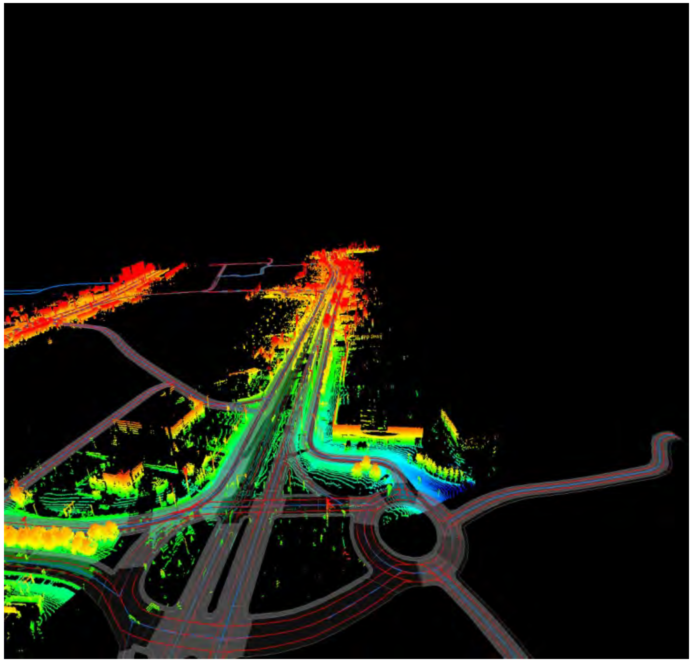
Individuálne autonómne vozidlá pohybujúce sa na cestách spolu s vozidlami riadenými ľuďmi

HD mapping: 3D model



Trajectory planning: lines

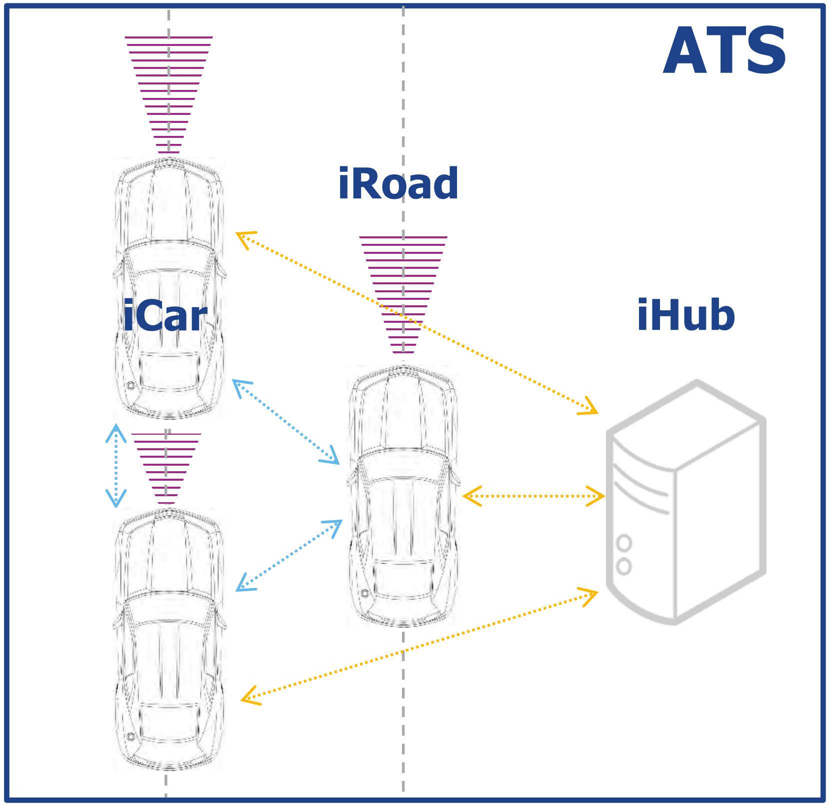




Lokálne riešenie: Autonómny Transportný Systém

ATS funguje na originálnej patentovanej technológii interakcie inteligentného vozidla s inteligentnou vozovkou

- Patentovaná technológia ATS je prispôsobená schopnostiam počítačov, ktoré riadia AGV, je „computer friendly“
- ATS je 10x presnejšie, 10x rýchlejšie, 10x lacnejšie
- Reakčný čas navigačného systému ATS je menej ako 0,1 s
- Schopnosť vyriešiť akúkoľvek dopravnú situáciu, križovatky, parkovanie
- Nízka cena navigačného systému ATS
- Nízka cena infraštruktúry ATS



Porovnanie LiDAR a ATS

ATS „i-cars on i-roads“ technológia
- cena ~ 10 000 EUR

LIDAR technológia so superpočítačom
- cena ~ 100 000 – 200 000 EUR

Porovnanie LiDAR a ATS

Porovnanie metód LiDAR scanning a ATS:

Technológia "LiDAR scanning"	Technológia ATS „i-cars on i-roads"
Zložitá: s veľkým tokom informácií, ktorú vie spracovať len supercomputer	**Jednoduchá:** s malým tokom informácií „computer friendly", stačí obyčajný počítač
Drahá: navigačný systém AGV ~ 100-200 tisíc €	**Lacná:** navigačný systém AGV ~ 12-15 tisíc €
Pomalá: (10-20 frames/s)	**Rýchla:** (100 frames/s) – umožňuje rýchlosti nad 100 km
Relatívna: poloha sa určuje len vzhľadom na okolie s presnosťou desiatok cm	**Absolútna:** poloha sa určuje absolútne s presnosťou ~ 1 cm
Nespoľahlivá: znížená kvalita orientácie v daždi alebo snehu	**Spoľahlivá:** funguje bez ohľadu na poveternostné podmienky
Globálna: plánuje sa na globálne použitie	**Lokálna:** plánujú sa komplexné lokálne systémy

Efektivita a komplexnosť ATS

- Univerzálny ATS komplexne vyrieši dopravu v danej lokalite, nákladnú aj osobnú
- Masové nasadenie elektromobilov s vyriešením ich dojazdu
- Výrazné zníženie energetickej náročnosti dopravy
- Vysoko organizovaná doprava permanentne riadená centrálnym počítačom
- Flexibilita – v prípade potreby sa zmeny alebo rozšírenia ATS dajú urobiť v krátkom čase
- Modularita – lokálne ATS systémy je možné ľahko spájať do veľkých celkov
- ATS zachová výhody individuálnej mobility a zároveň prinesie výhody verejnej dopravy

Ekonomické benefity

- Investícia do ATS sa podľa štúdie uskutočniteľnosti od Ernst&Young vráti zákazníkovi veľmi rýchlo
- Vozidlá budú plne využité 24 hodín denne, 7 dní v týždni
- Podstatné zrýchlenie dopravy pri znížení nákladov na dopravu
- Automatický prevoz tovarov a materiálov v noci s využitím lacného nočného prúdu
- Náklady na ATS sú neporovnateľne menšie ako náklady na iné autonómne systémy
- Plné využitie súčasnej cestnej siete a priemyselne vyrábaných elektromobilov všetkých typov a veľkostí

Sociálne a ekologické benefity

- Veľmi výrazné zníženie počtu dopravných nehôd na cestách, počtu zabitých aj zranených – veľké úspory liečebných nákladov a straty pracovnej sily
- ATS odvezie individuálne každého: deti, starých aj imobilných
- Masové nasadenie elektromobilov podstatne zníži produkciu emisií a hluku
- Nahradenie fosílnych palív v doprave zelenou elektrickou energiou (hlavne solárnou a z atómových elektrární)

Vývoj a produkcia ATS

Vytvorilo sa konzorcium silných Slovenských univerzít a inovatívnych firiem
Konzorcium združuje viac ako sto vedcov, vysoko kvalifikovaných špecialistov v odbore IKT a inžinierov rôznych špecializácií

Centrálne riadenie ATS
- Virtual Reality Media, a.s. Trenčín
- Trenčianska Univerzita., Trenčín

Navigačný systém pre bezpilotné vozidlá
- Kvant s.r.o.., Bratislava
- VRM a.s., Trenčín
- Fakulta Matematiky, Fyziky a Informatiky, Univerzita Komenského Bratislava

Bezpečnostný systém pre bezpilotné vozidlá
- Kvant s.r.o., Bratislava
- Fakulta Matematiky, Fyziky a Informatiky, UK Bratislava

Riadiaci systém bezpilotných vozidiel
- Ústav Automobilovej Mechatroniky, STU, Bratislava

Telecommunikačný systém ATS
- Ústav Telekomunikácií, STU, Bratislava

Systém počítačovej bezpečnosti v ATS
- Beset s.r.o., Bratislava

Záver

Za predpokladu, že štát podporí výskum a vývoj v smere Autonómna mobilita:

- **Je tu príležitosť dostať Slovensko do svetovej technologickej ligy a zvýrazniť imidž Slovenska ako modernej priemyselnej krajiny**

- **Slovensko môže vybudovať a prevádzkovať prvý „Smart Industrial Park“ aj jedno z prvých Smart City na svete**

- **Slovenský priemysel môže vyrábať a exportovať autonómne dopravné systémy na mnohé miesta vo svete, na letiskách, v priemyselných areáloch, v rezortoch oddychu, výstavných priestoroch a tiež nových Smart Cities**

- **Zo štrukturálnych fondov EU sa na podporu významných a strategických projektov sa práve v týchto týždňoch rozdeľuje 1,044 miliardy EUR. Bude v tom zahrnutá aj Autonómna mobilita?**

SMART CUSTOMIZATION OF 3D SENSORS WITH APPLICATION SPECIFIC ALGORITHMS

Andreas Hoffmann [1]
[1] Application Engineering Team lead EMEA, LMI Technologies

Abstract
Solving specific application needs is one of the challenges in today's 3D sensor market. A modern factory cannot only care about speed, but also has to reach a high precision in quality control through accurate and reliable measurement data. In order to achieve this, LMI will demonstrate different options that allow the user to adapt 3D smart sensors to solve their unique inspection problems. With the help of real life examples, LMI will explain how software developers can test their own applications in a safe offline environment without the need for a physical sensor. Also how working with large 3D point clouds can be simplified by adding the data-processing power of one or more PCs to an inspection solution. Additionally, the presentation will highlight how users can develop custom measurement algorithms that run directly on 3D smart sensors. This extends the functionality of the sensors and allows for the flexibility needed in a fast changing environment.

SMART CUSTOMIZATION OF 3D SENSORS WITH APPLICATION SPECIFIC ALGORITHMS

2nd International Conference 3D Measurement and Imaging

22 September 2017

Andreas Hoffmann
Application Engineering Team lead EMEAR

CONFIDENTIAL

KVANT LMI TECHNOLOGIES

ABOUT LMI TECHNOLOGIES

QUICK FACTS

Owned by TKH Group

39+ years experience
1978 – Present

One of our Selcom displacement sensors developed in the 1970s

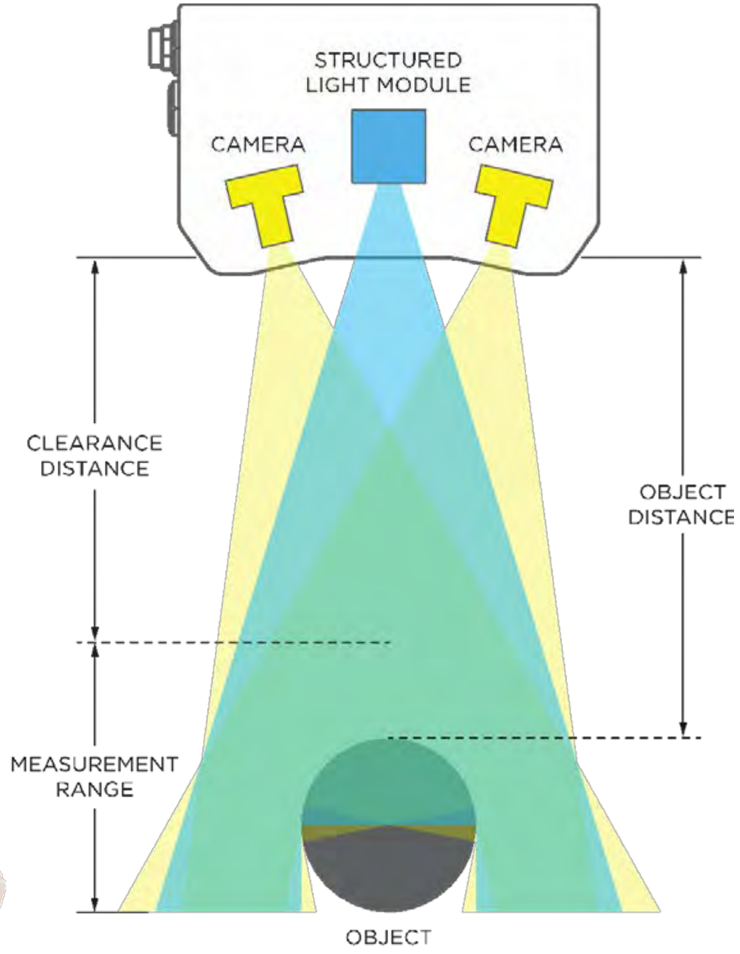
100+ patents
and 220+ employees

110,000+ sensors
in the field

ABOUT LMI TECHNOLOGIES

TYPICAL INLINE MEASUREMENT DEVICES

- » 3D Sensor Technologies:
  - ◉ Laser triangulation
  - ◉ Structured light
- » Industrial housing
- » Calibrated once in the factory, holds accuracy in industrial environments
- » Embedded processing makes hardware “smart”



SMART 3D-SENSORS

EXTENDABLE 3D SENSOR OVERVIEW

- » Core Hardware/Software platform
  - Acquisition Modules
  - Measurement Tools
  - Interface Modules

- » Open Programming Interface
- » Open Tool Interface
  - Native Sensor C API
  - Visualisation Functions
  - 3rd Party Library Support

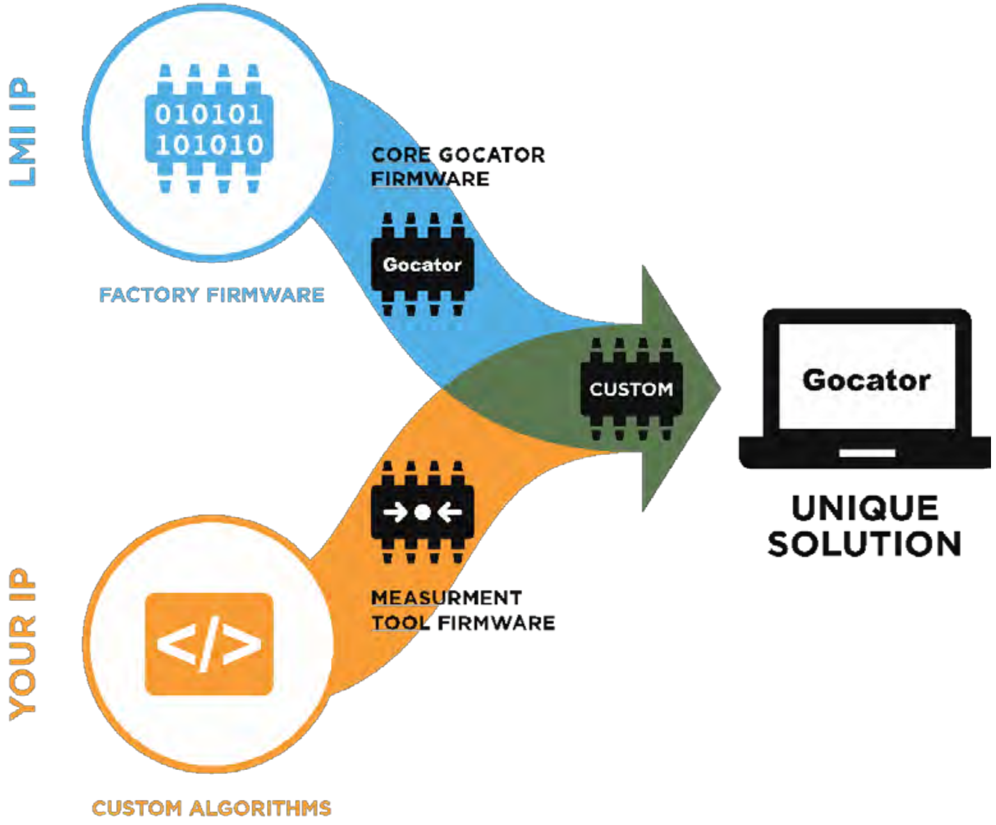
GOCATOR DEVELOPMENT KIT (GDK)

Visual Studio

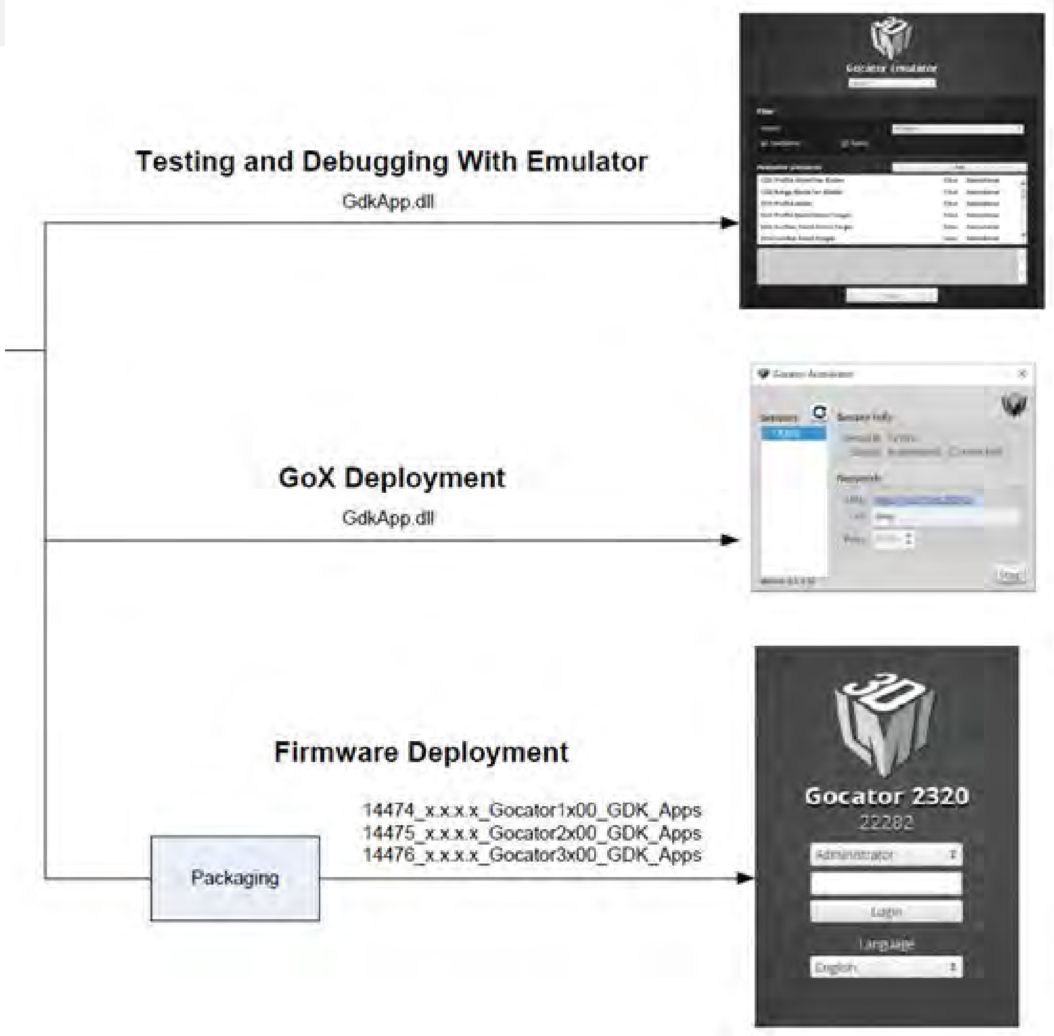
Standard Firmware + Custom Tool = Custom Firmware

GOCATOR DEVELOPMENT KIT (GDK)

- Users customize their Gocator for even more control over the inspection process
- Extend the Gocator firmware
- IP and pricing protection
- Integrators can modify their algorithm on-site
- Reduces development and integration time



GOCATOR DEVELOPMENT KIT (GDK)



GOCATOR DEVELOPMENT KIT (GDK)

```
min = profileData[regionStartIndex];

numHighPeaks = 0;
numLowPeaks = 0;


// loop through region
for (i = regionStartIndex; i <= regionEndIndex; i++)
{
    if (profileData[i] != k16S_MIN && ((profileData[i] > regionZStart) && (profileData[i] < regionZEnd)) && deltaInt > 0)
    {
        // find max
        if (profileData[i] > max)
        {
            maxPos = i;
            max = profileData[i];
        }
        // find min
        if (profileData[i] < min)
        {
            minPos = i;
            min = profileData[i];
        }

        if (detectHighPeak && profileData[i] < max - deltaInt)
        {
            if (numHighPeaks >= maxHighPeaks) /* not enough spaces */
                kThrow(kERROR_ABORT);

            highPoints[numHighPeaks].x = maxPos * GdkDataInfo_Scale(itemInfo)->x + GdkInputItem_Offset(item)->x;
            highPoints[numHighPeaks].y =
            highPoints[numHighPeaks].z = profileData[maxPos] * GdkDataInfo_Scale(itemInfo)->z + GdkInputItem_Offset(item)->z;
```

algorithm example

CAPABILITY

- Allows FAE/AE and users to develop measurement tools for customers
  - With same capability as internal tools.
- Covers all Gocator series running on FW 4.x
- Supports Range, Profile, Surface and Intensity data
- Works with Gocator Emulator, Gocator accelerator, and actual sensor
  - Accessible from web interface, SDK and PLC protocols etc

WHY AND WHEN NEED A GDK TOOL

Sensor head only, no PC or controller required
3D point cloud and surface tools without extra controller/processor.

SENSOR

CONTROLLER

3D CONTROLLER

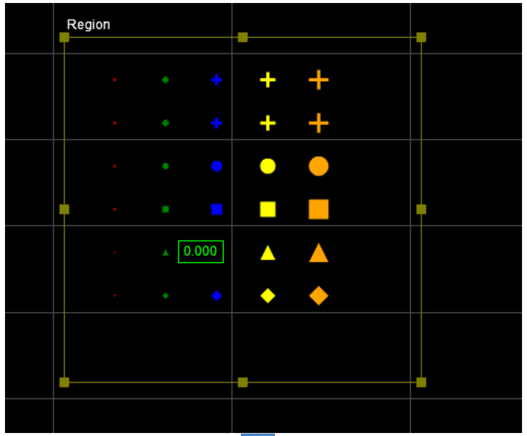
SENSOR

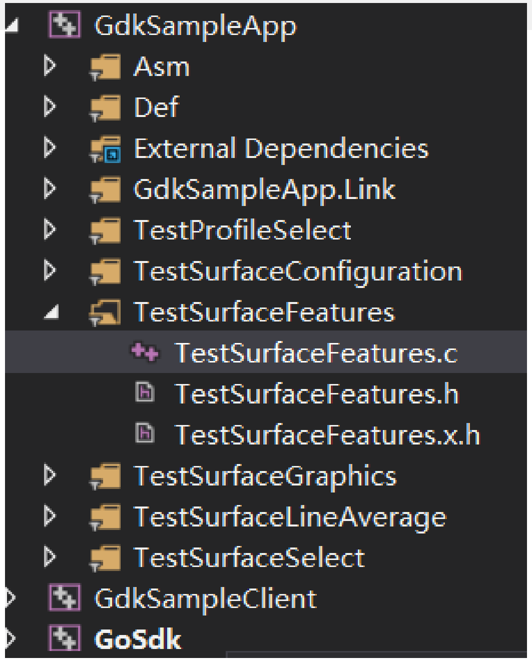
CONTROLLER

3D SOFTWARE

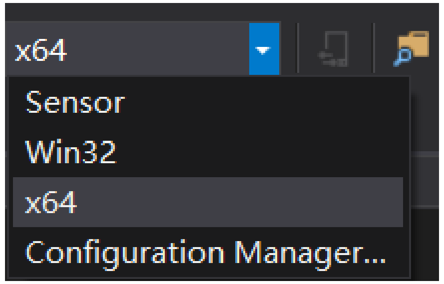
WHAT IS GOCATOR DEVELOPMENT KIT

Graphic Rendering capabilities





Cross-platform integrated environment



Reduced development and integration Time

Easy Hands-on sample code for both profile and surface tools

HOW DOES IT WORK

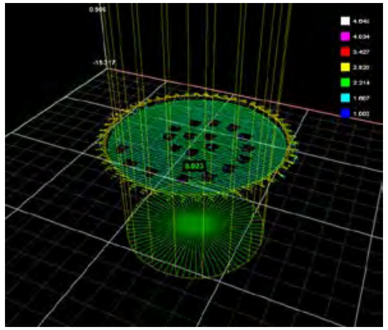
» Register Tool

Framework can thus identify your tool

```
kBeginAssembly(Tool, ToolAsm, TOOL_VERSION, GOCATOR_VERSION)
    kAddDependency(GdkLib)
    kAddType(TestProfileSelect)
    kAddType(TestSurfaceSelect)
    kAddType(TestSurfaceConfiguration)
    kAddType(TestSurfaceGraphics)
    kAddType(TestSurfaceLineAverage)
    kAddType(TestSurfaceFeatures)
kEndAssembly()
```

» Implement tool runtime functions

- VDescribe: Define parameters, feature and measurement outputs
- Vstart: Called when sensor start, resource allocation and initialization
- Vprocess: Main place to implement your algorithm
- Vstop: Called when sensor stops, resource release and cleanup

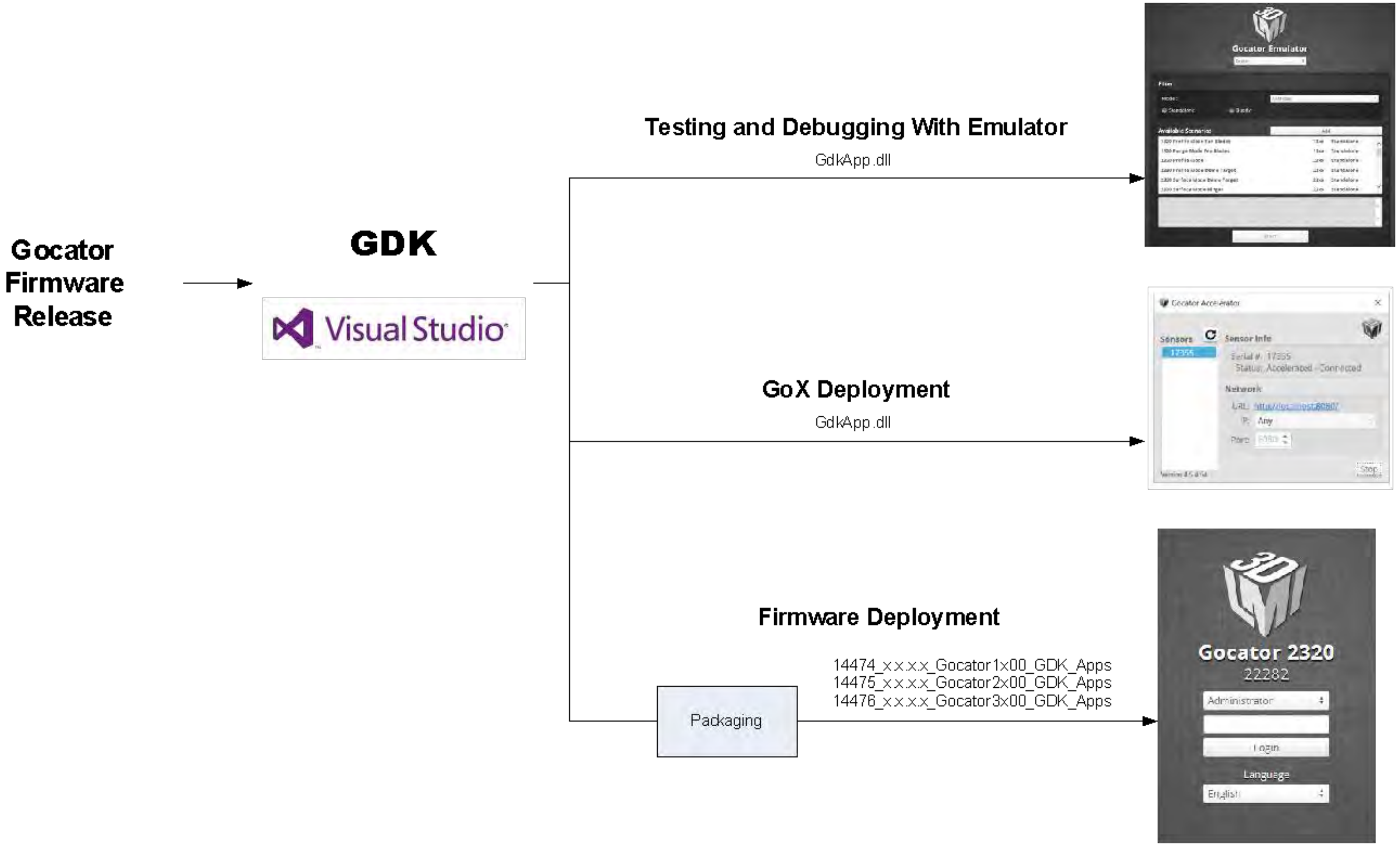


WORKFLOW

When using GoX, Sensor does NOT require firmware with the GDK tool

Why is this important?

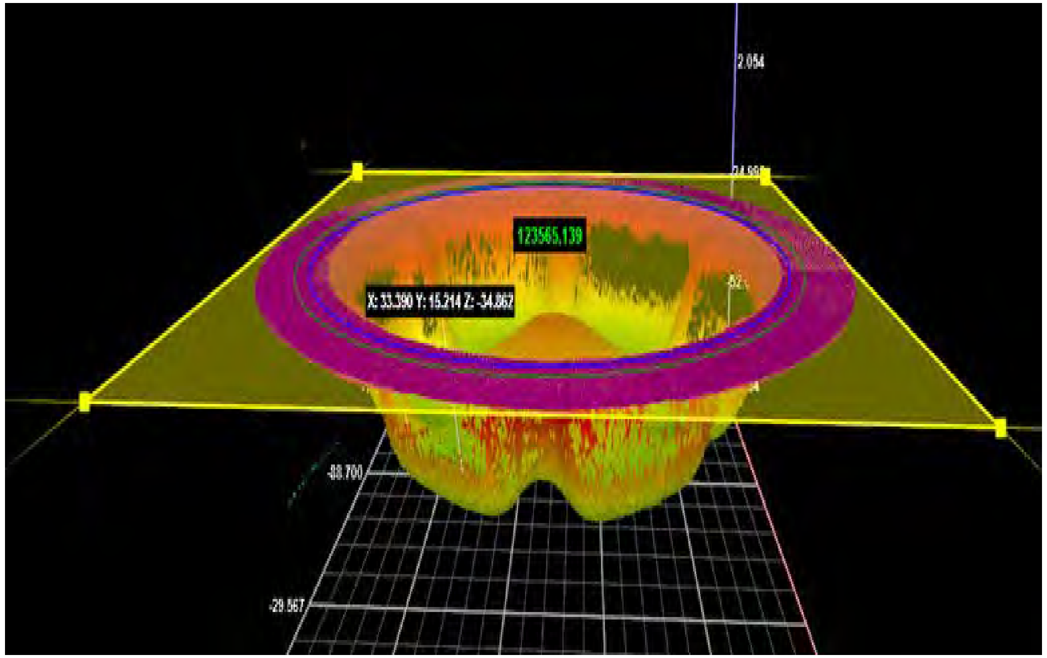
Allows integration with 3^{rd} party software



WORKFLOW

VISUALIZATION

- Create regions, lines and points on the visualizer.
- Graphics on 2D and 3D visualizer



APPLICATION EXAMPLES

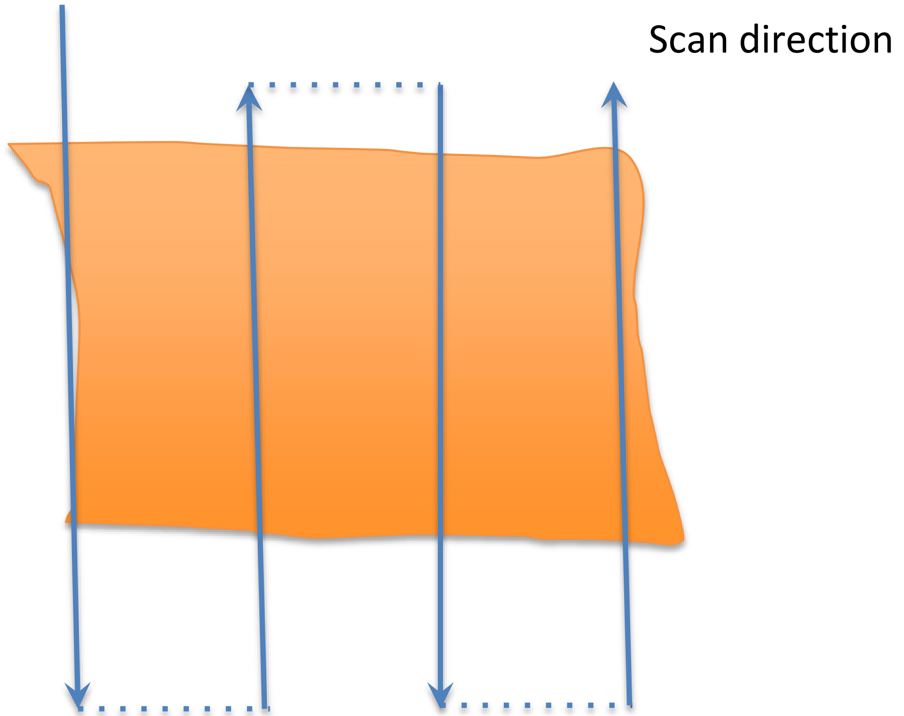
LMI TECHNOLOGIES

APPLICATION EXAMPLES

- State machine based processing
- Application specific measurements
- Combine intensity and 3D height map processing
- 3rd party library and camera integration
- IP and pricing protection

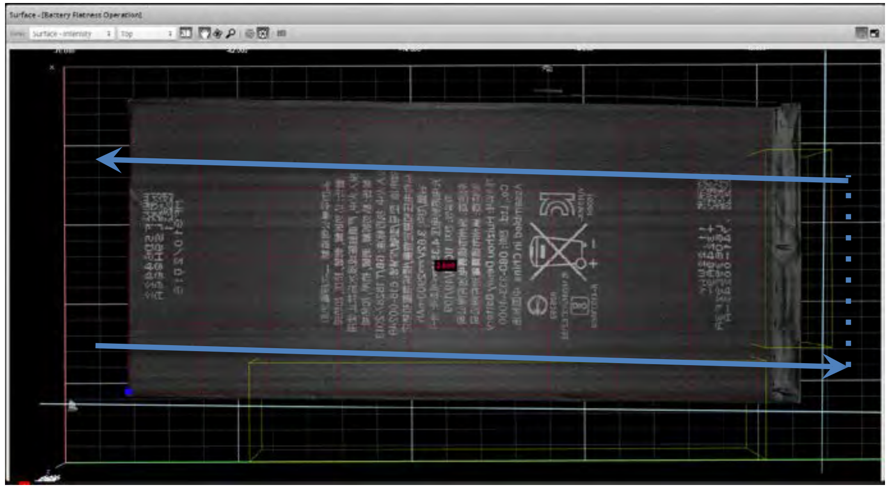
STATE-MACHINE BASED PROCESSING

» Scans are processed differently based on the position in the sequence
» Sensor mounted on a robot / transport to scan over a large part
» Example: Battery flatness



BATTERY FLATNESS APPLICATION

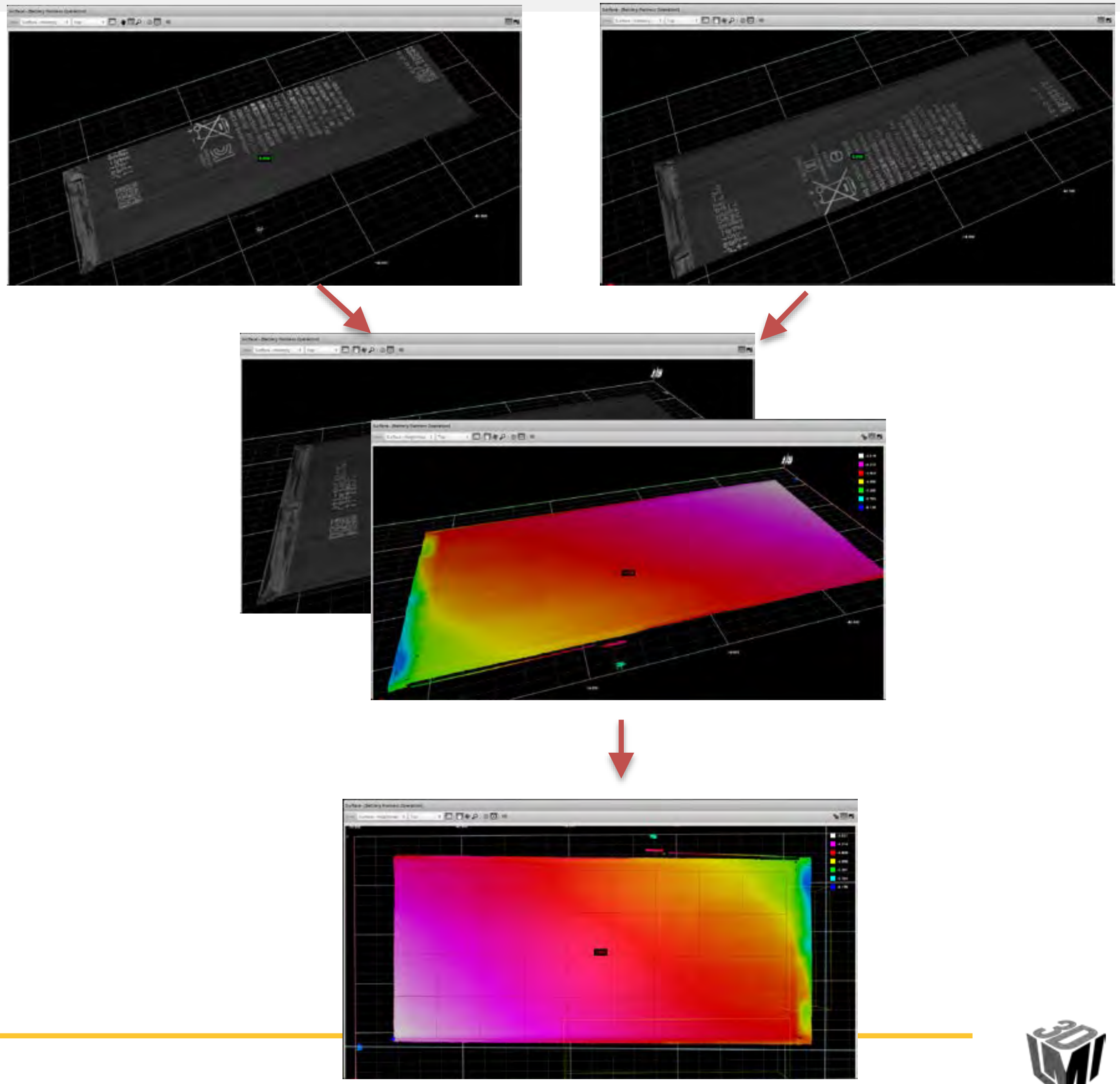
» Customer wants to measure flatness in different regions of a battery
  - Dimension ~ 50mm*120mm;
  - Repeatability within 10um;
  - CT within 2 seconds;
  - Whole region is divided into 36 sub-regions (4*9 grid);
    - For each sub-region, the flatness is calculated;
    - A flatness number is also calculated for the whole grid region;
  - Cost effective;
  - Real time visualization;



BATTERY FLATNESS APPLICATION

» Applications

1. G2420 scanning twice;
   - 3kHz frame rate;
   - 0.1mm Y resolution;
2. Stitch the data together
   - Based on motion slide movement;
3. Locate the part based on edge detection;
4. Measure flatness in required regions;



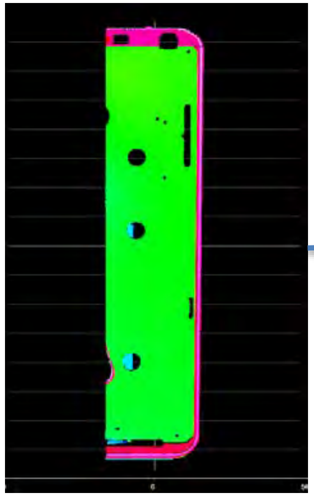
COMPLETE ENCLOSURE INSPECTION

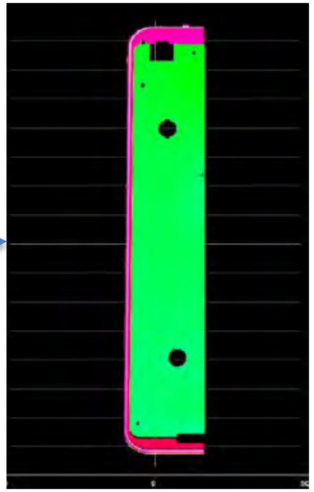
» Data combine

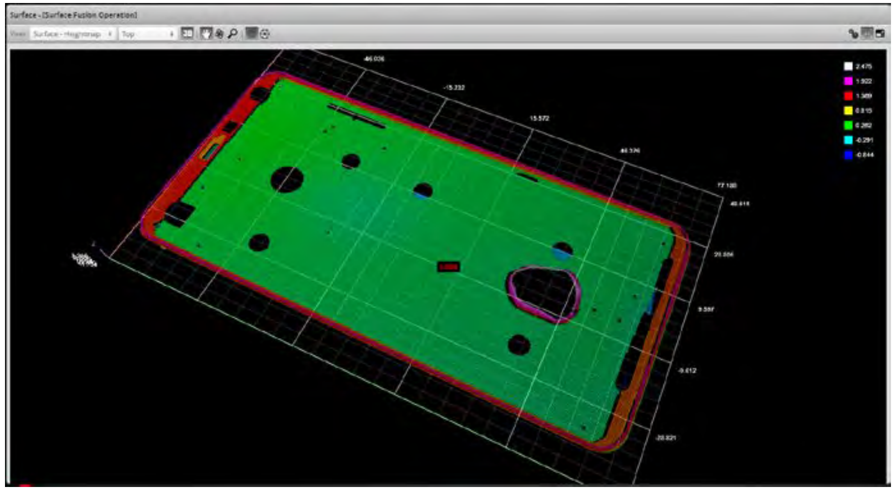
Buffe
r

Combine

Above mentioned process can be done here







SPECIALIZED SHAPE / DEFECT MEASUREMENTS

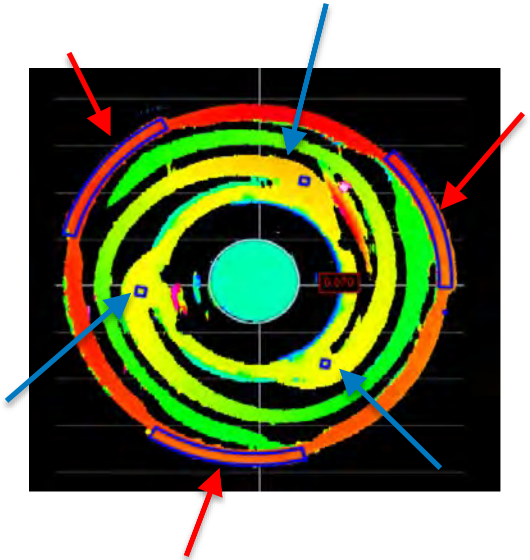
- Anchoring/Alignment,
- Filtering,
- Measurement
- Inspection
- ……

Customization Needed!

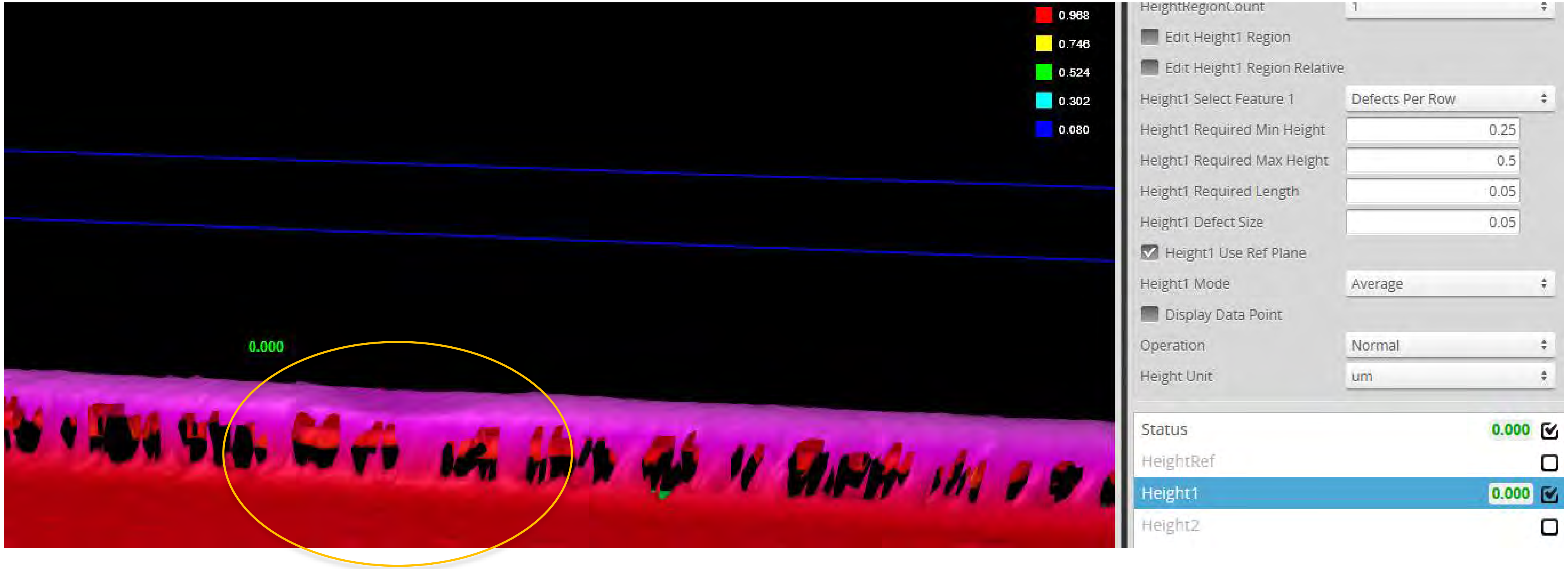
APPLICATION-SPECIFIC DETECTION REGIONS

» Customer wants to measure the maximum height from the RED region to BLUE region;
  - Sample Size 9mm;
  - CT 1 second;
  - Repeatability 10um;

» Algorithm
  1. Locate the center and rotation;
  2. Get points in 3 blue region and fit a plane;
  3. Calculate the distance from each point in red region to ref plane;
  4. Find maximum distance;
  5. Output measurement value and OK/NG;

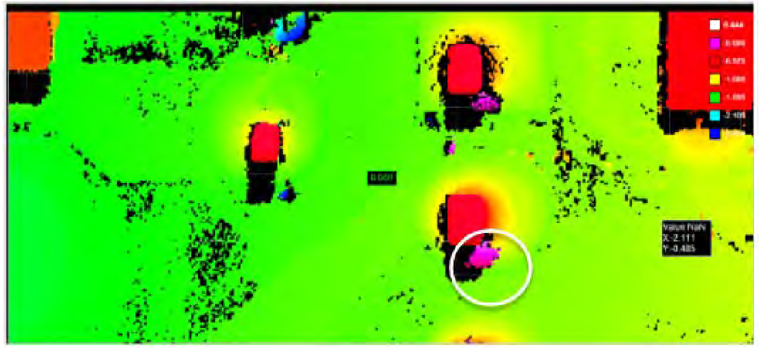


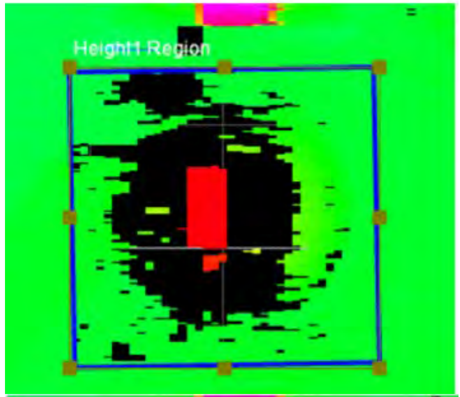
APPLICATION-SPECIFIC SHAPE / DEFECT DETECTION

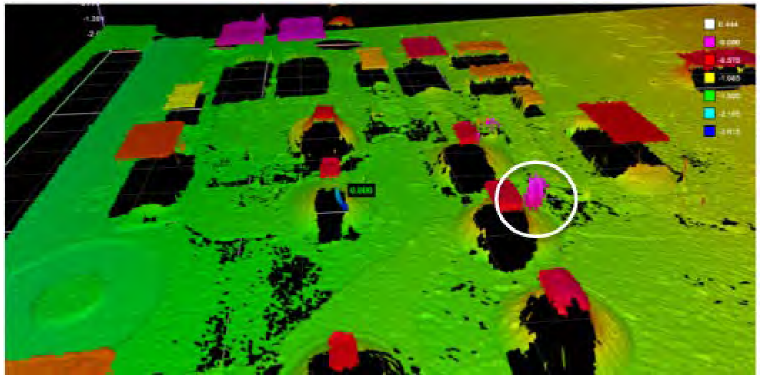


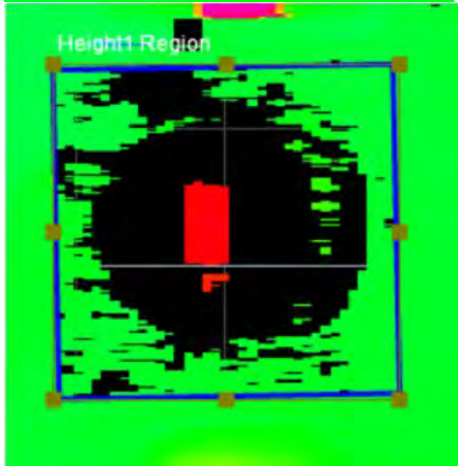
APPLICATION-SPECIFIC FILTERING

» Filtering algorithm tailored using the knowledge of the whole surface and part positions





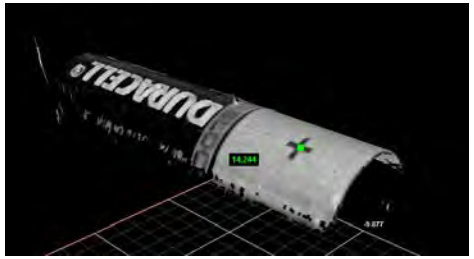




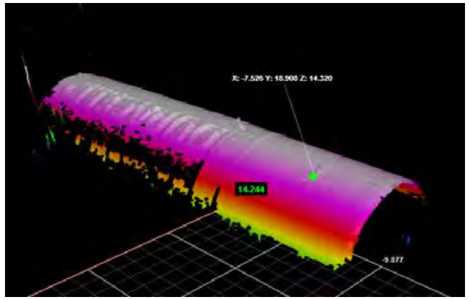
COMBINED INTENSITY AND 3D HEIGHT MAP PROCESSING

Measure position at the cross point

Locate cross position using 2D image processing

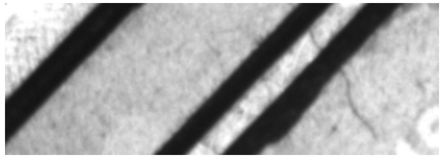


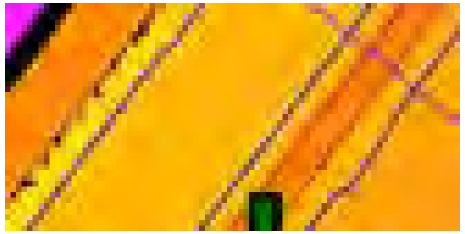
Locate cross position using 2D image processing



INTEGRATE WITH 3RD PARTY LIBRARY OR CAMERA

5MP photos

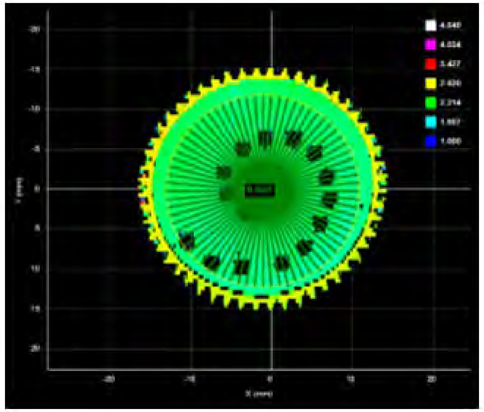


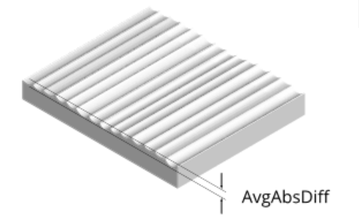


Gocator height map

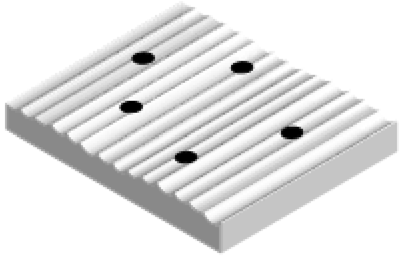
IP AND PRICING PROTECTION

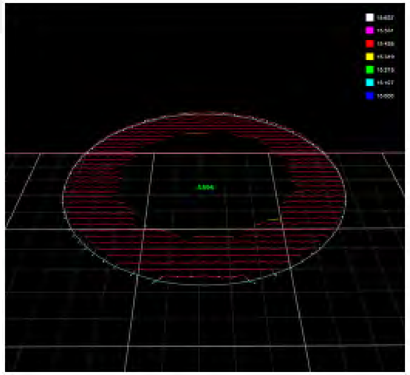
GDK – PRE-BUILT CUSTOM TOOLS



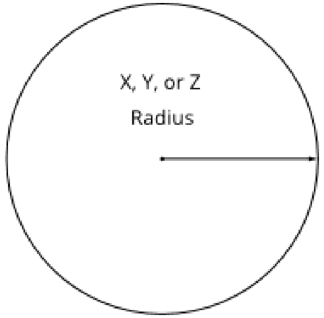


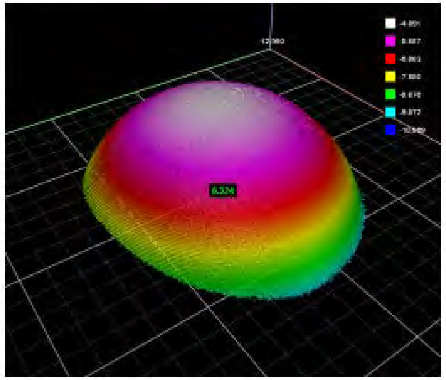
Radial surface texture



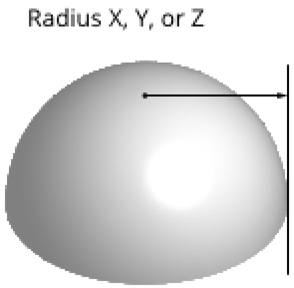


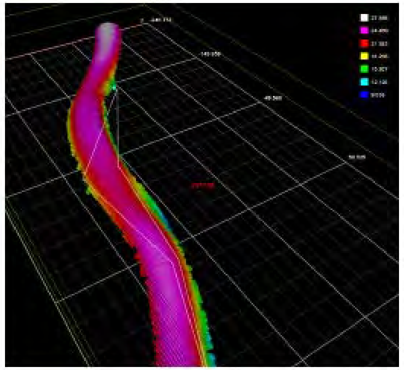
Surface circle fit



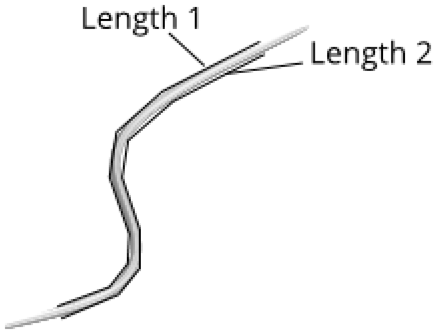


Sphere fit





Irregular length



LMI TECHNOLOGIES

INSPECTION AND DETECTION OF MATERIALS USING LINE SCAN CAMERAS

Pavol Polóni[1]
[1] Camea

Abstract

UniscanDETECTOR is a visual inspection system designed for defect detection on metal plates, nonwoven textiles, foils, paper, etc. System was developed as highly modular. It is therefore fully configurable according to customer's requirements. It can be used in various phases of production process, including slitting quality inspection.

For surface scanning the system uses fastest line-scan cameras actually in production with bandwidth over 20 Gb/s. This also brings the need for high quality illumination of material, which was developed specially for this purpose in the form of an advanced LED unit. Thanks to the use of state-of-the-art components UniscanDETECTOR is able to detect defects as small as 0,1 mm2 at speeds up to 2000 m/min and strip width up to 5 m.

Inspection results are visualized in real-time on several distributed consoles to provide a feedback for output quality of material. Operator can therefore instantly respond and eliminate rising problem in the shortest possible time. Significant impact for production efficiency is given by the fact that detected defective product doesn't have to be uselessly processed further. All inspection reports are also archived and statistically processed to provide an overview of long-term production quality development.

APLIKÁCIE V PRIEMYSLE

APLIKÁCIE V DOPRAVE

camea

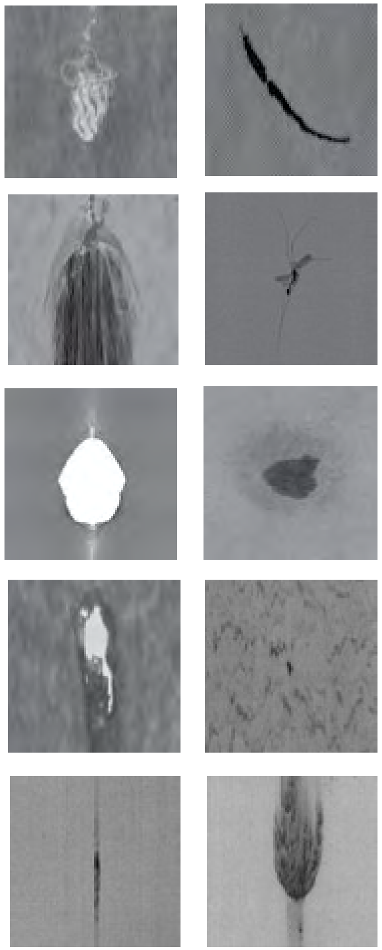
CAMEA vo svete

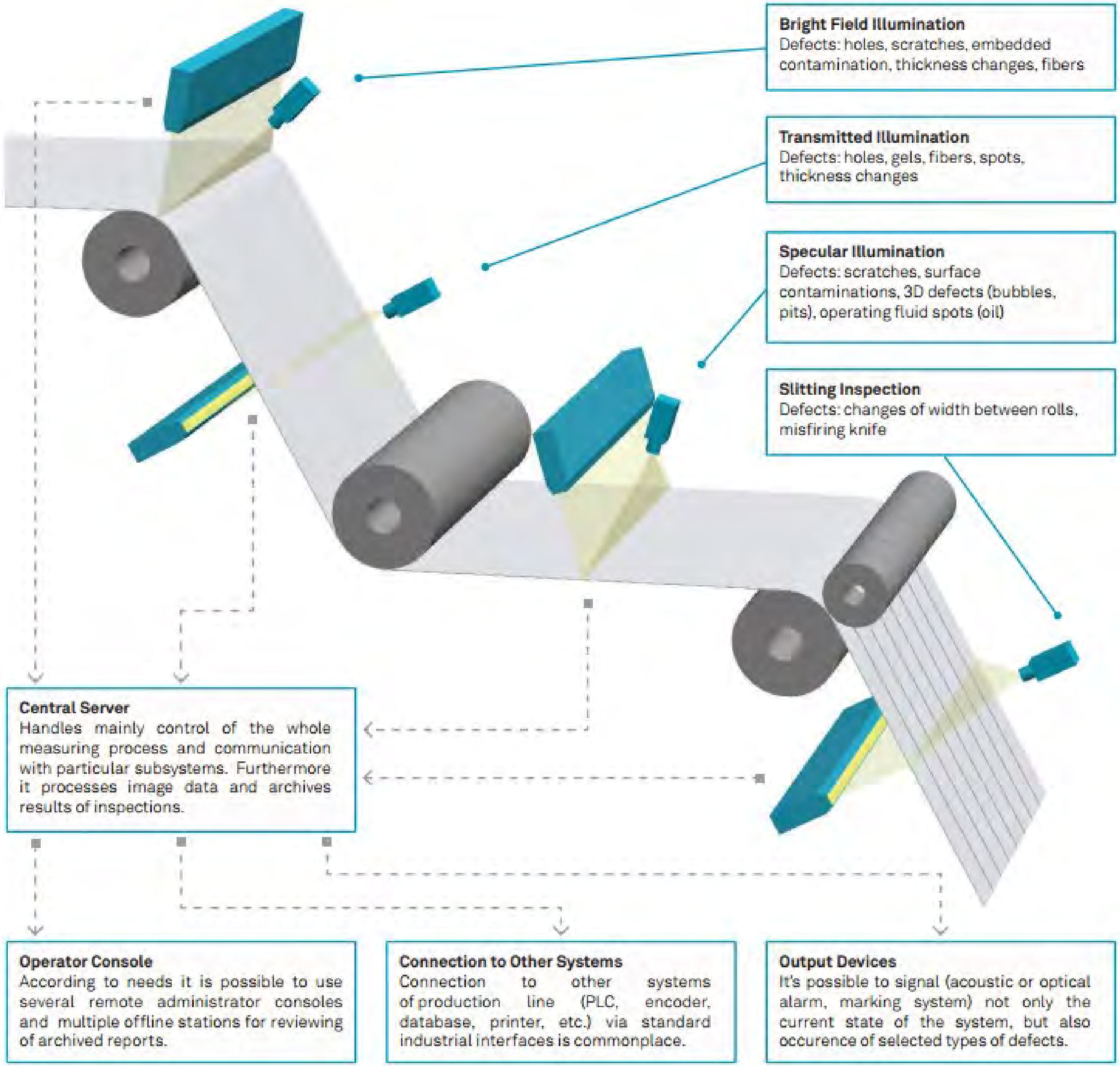
Aktuálny prehľad inštalácií v doprave

Servis	Stát	Město	MUR/SDDÚ	SPEED	DJČ	WIM	DD	KTDS	Kamera	Rozvaděč
Ano	ČR	Zlín	5						12	11
Ano	ČR	Šternberk		2					2	2
Ano	ČR	Praha	79	37	20	8	74	160	654	239
Ano	ČR	Bílina	1						4	4
Částečně	ČR	Ústí n/L, D8	6	2	11	2	2		58	33
Částečně	ČR	Ostrava, Klimkovice	2	3	1				15	8
Částečně	ČR	Brno	1		1	1			8	5
Podpora	ČR	Kladno	1		2				9	9
Částečně	Polsko	-	33			15			170	66
Podpora	Rakousko	-				11			20	
Podpora	Mexiko	-				6			18	6
Podpora	Itálie	Tierst	1						8	2
Podpora	Rusko					44			128	44
Podpora	Kazachstán					4			12	4
-	Keňa					4			17	13
CELKEM			**129**	**44**	**35**	**87**	**76**	**160**	**1135**	**446**

UniscanDETECTOR

SEA 2017





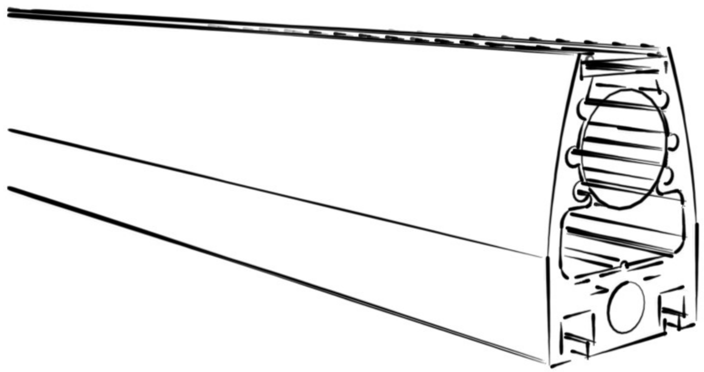
camea

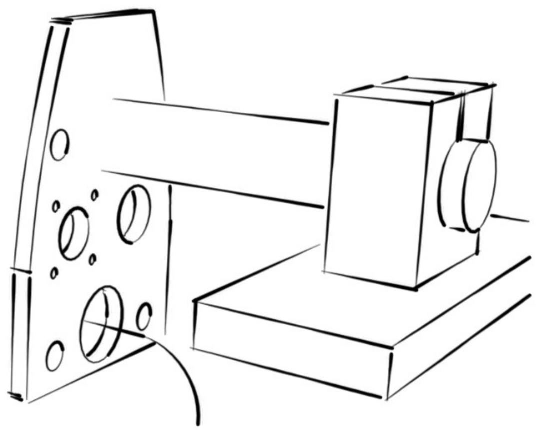
Novinky

- Tipický systém 300 x 300 µm pri 4,5 m šírke a 1200 m/min
  - Kamery 70 kHz 4096 pix…. 280 MB/s
- Upgrade na 100 x 100 µm pri 4,5 m šírke a 1200 m/min
  - Kamery 200 kHz 11000 pix…. **2200 MB/s na 1 kameru**

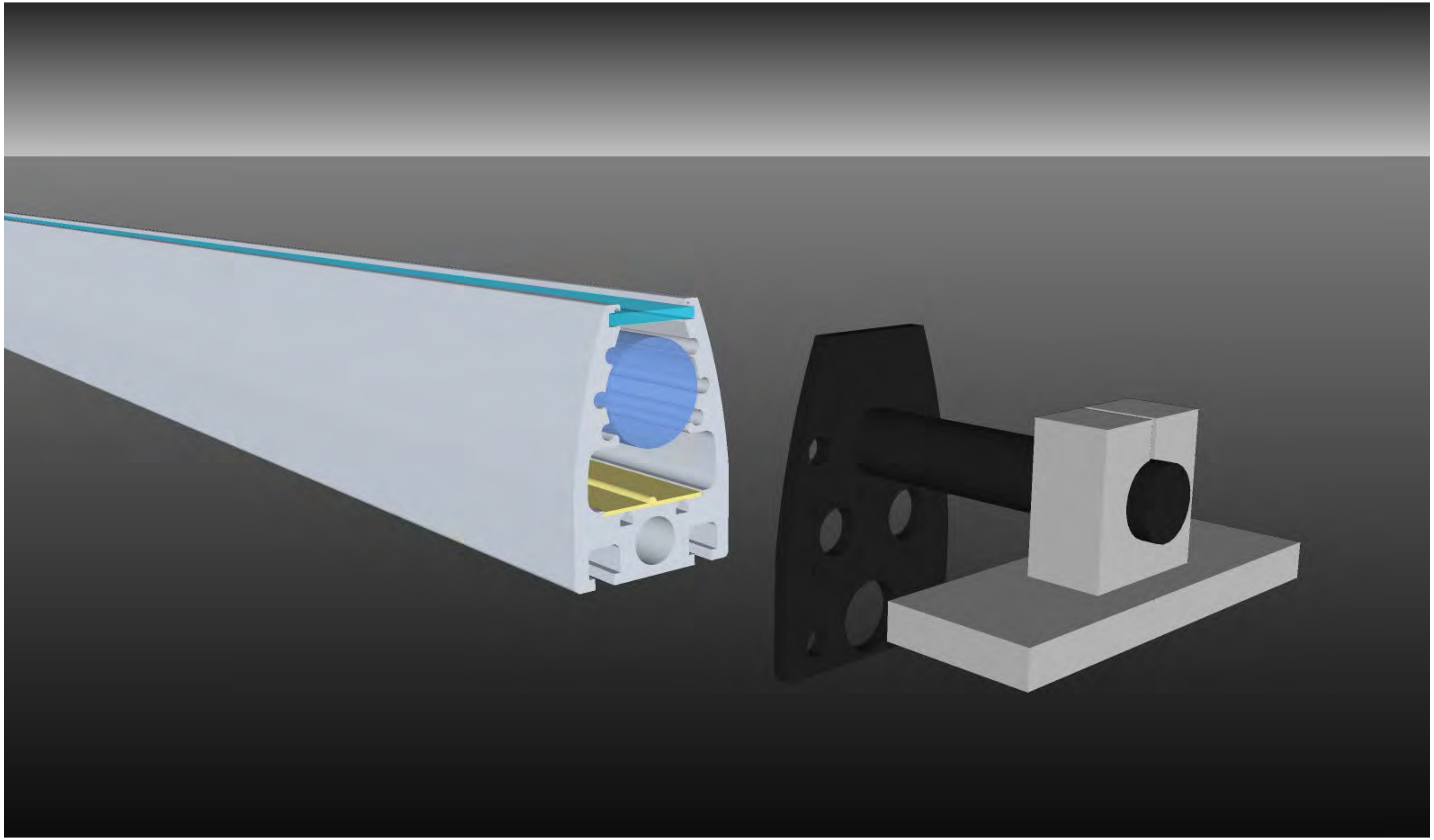
Líniové LED svetlo

- Dimenzované pre 200 kHz lps (expozicia 4 µs/r)
- Návrh vlastný extrudovaný AL profil 6000 mm
- 2500 W/m (LED čipy 10W, rozteč 4 mm)
- Chladenie kvapalinou s turbulentným prúdením
- Intenzita cca 12.000.000 lux

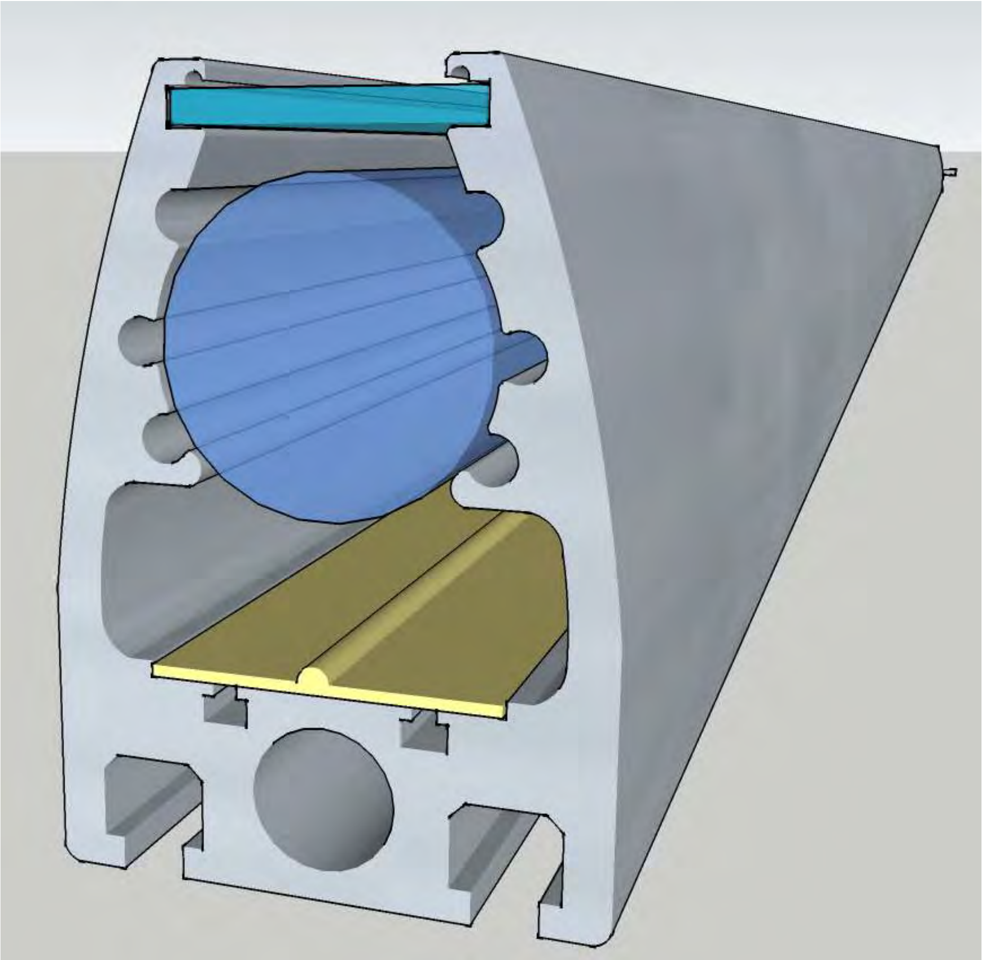


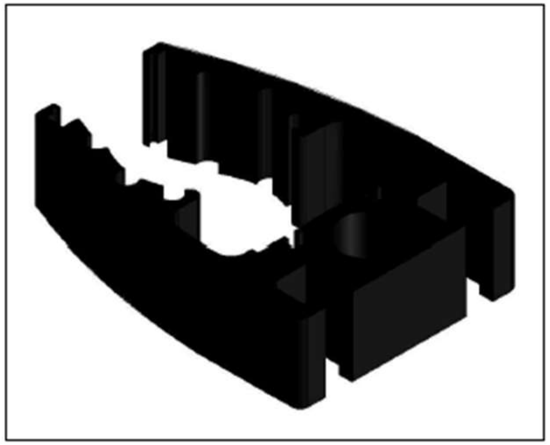


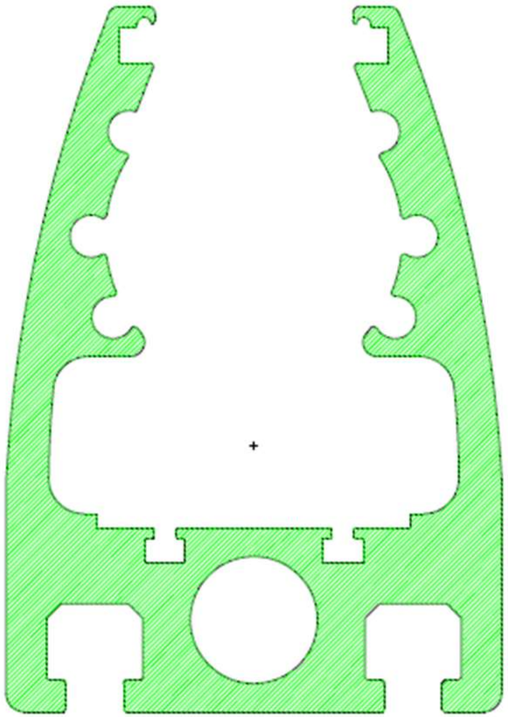
Líniové LED svetlo – 3D model



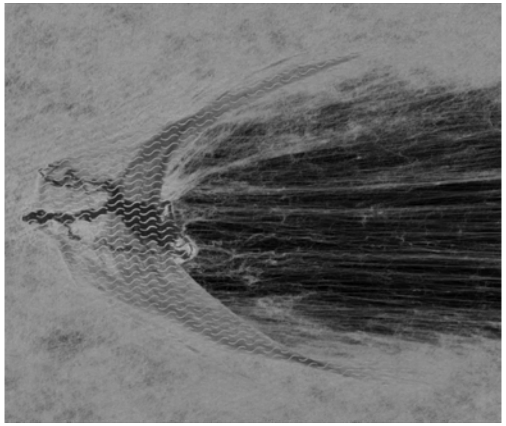
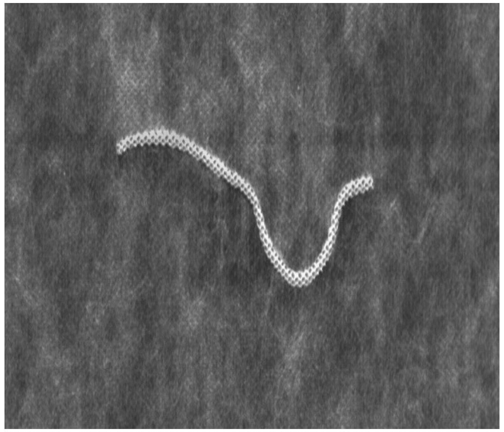
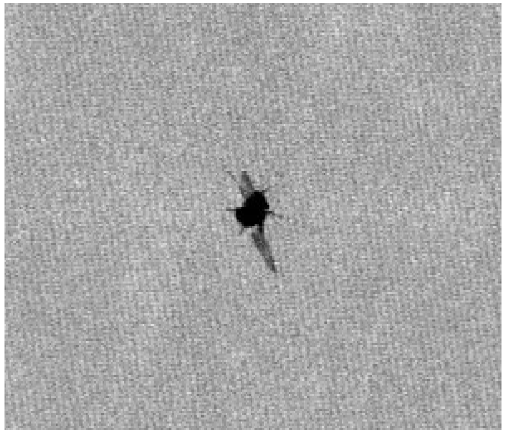
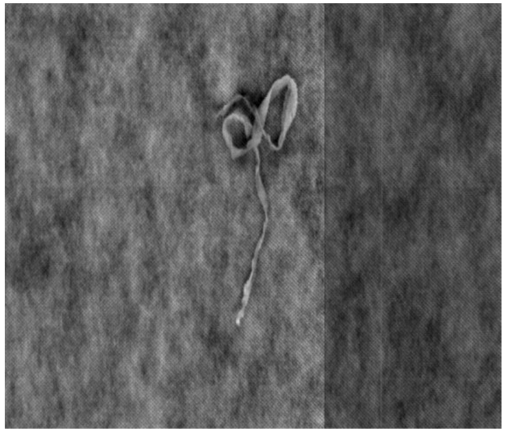
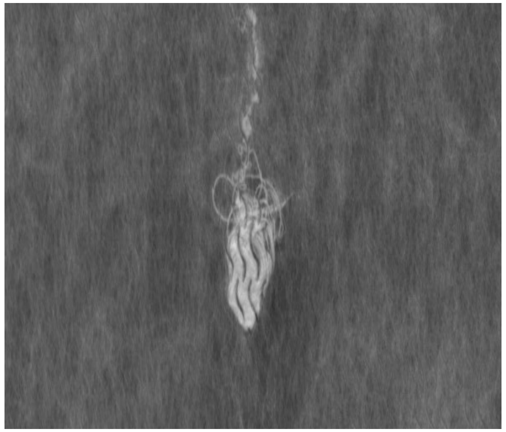
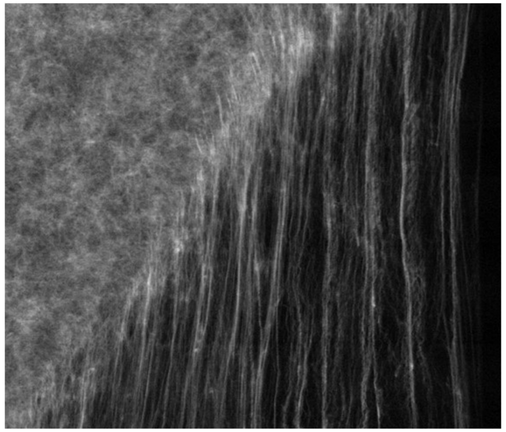
Extrudovaný profil



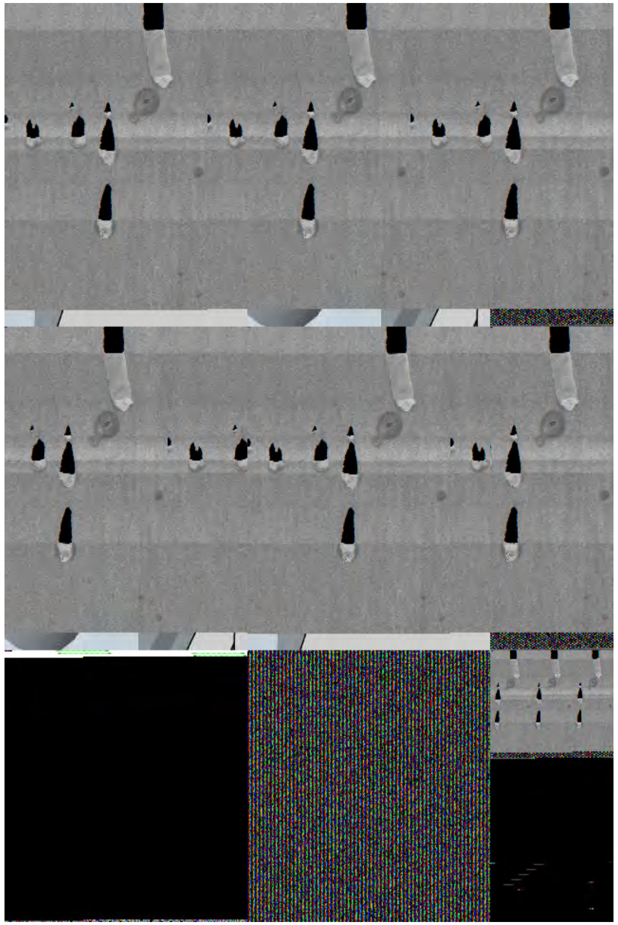


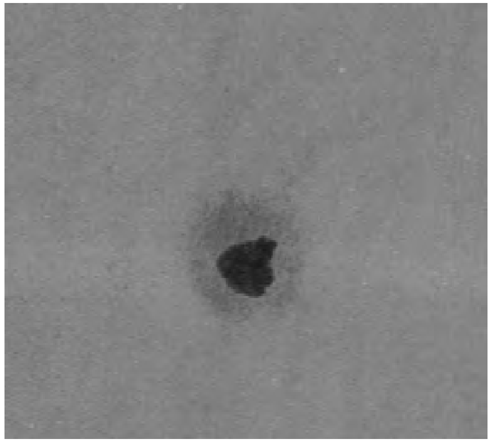


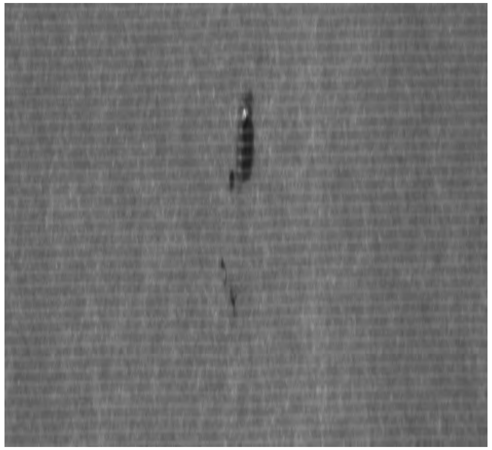
Galéria - netkaná textília

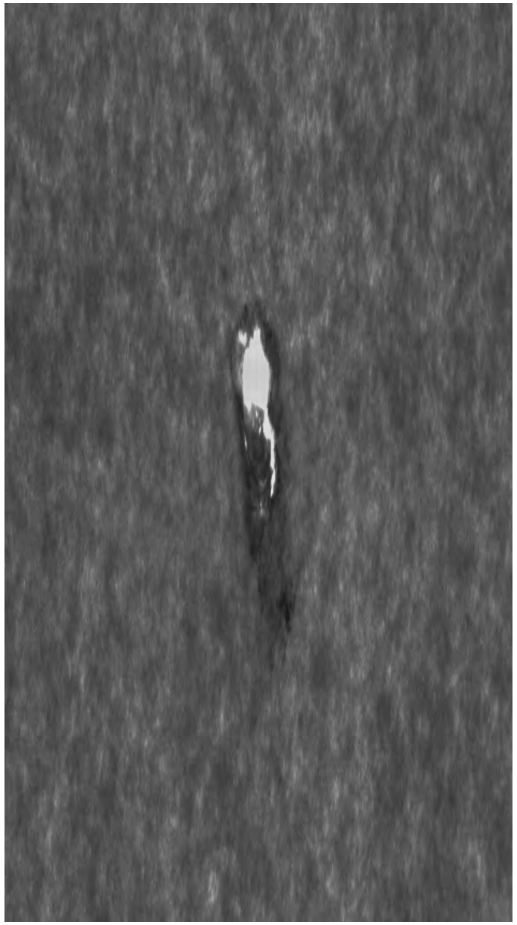







Galéria - papier

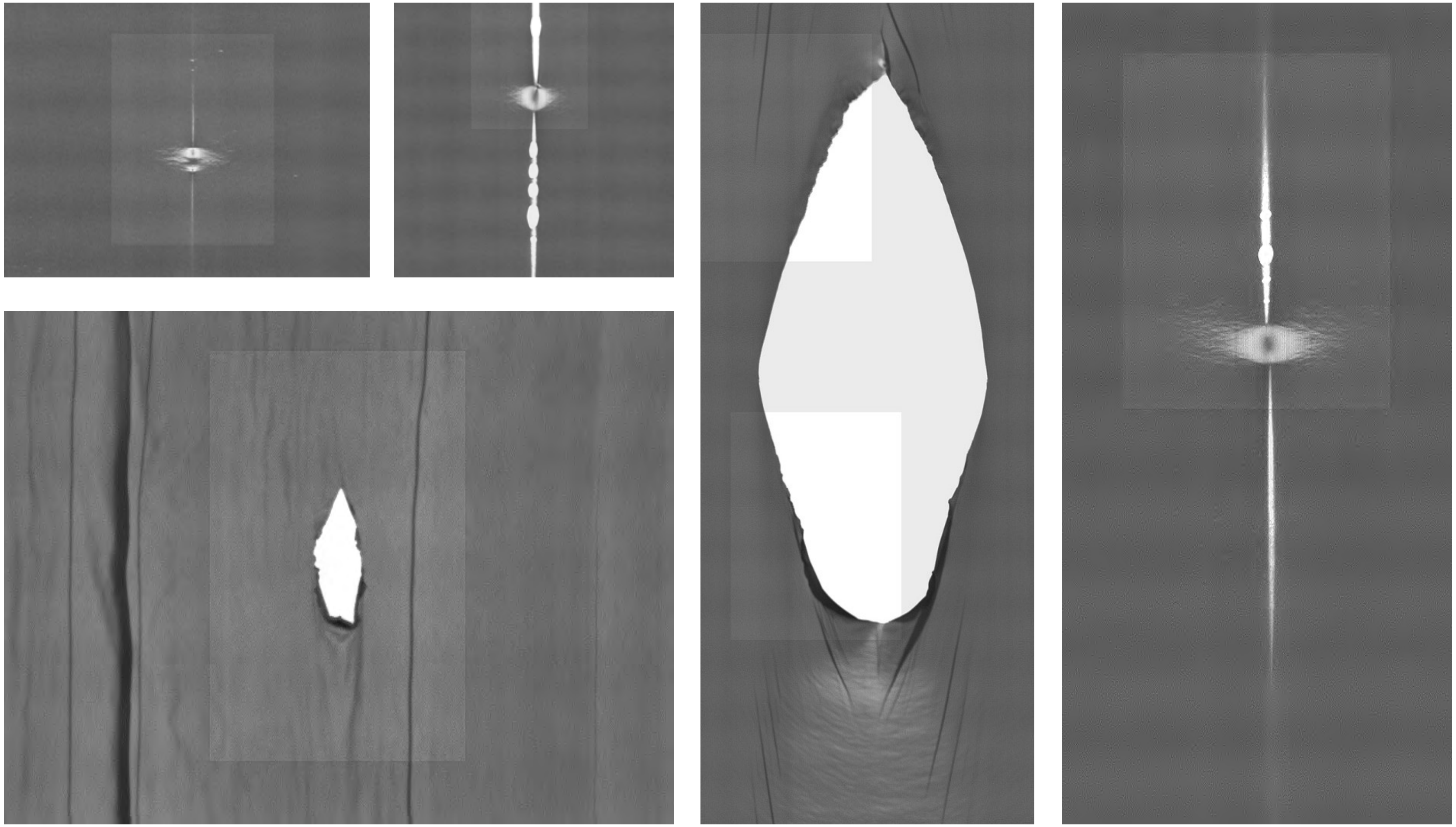




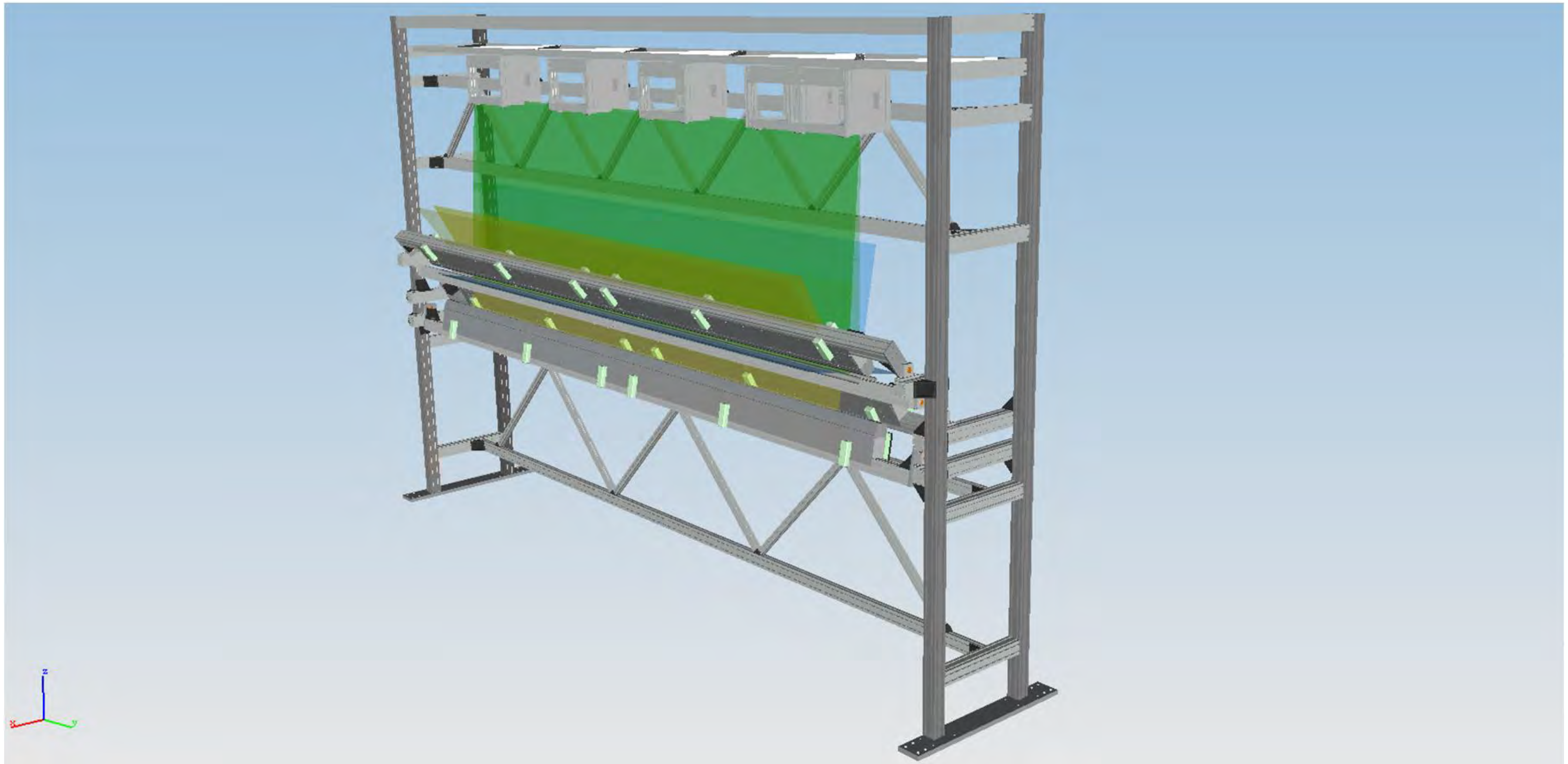




Galéria -fólia

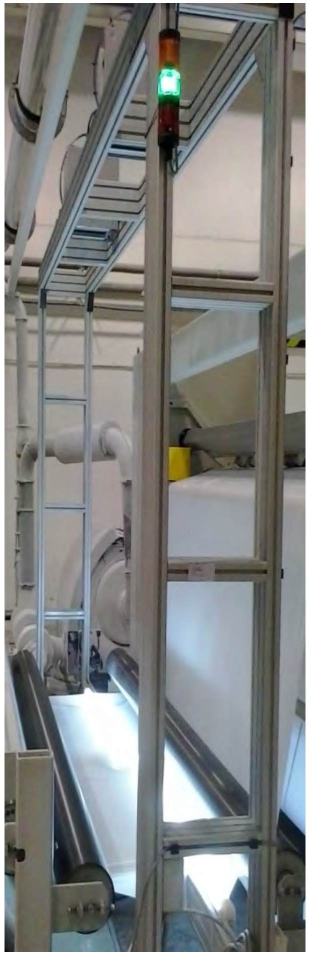


Model kamerového portálu



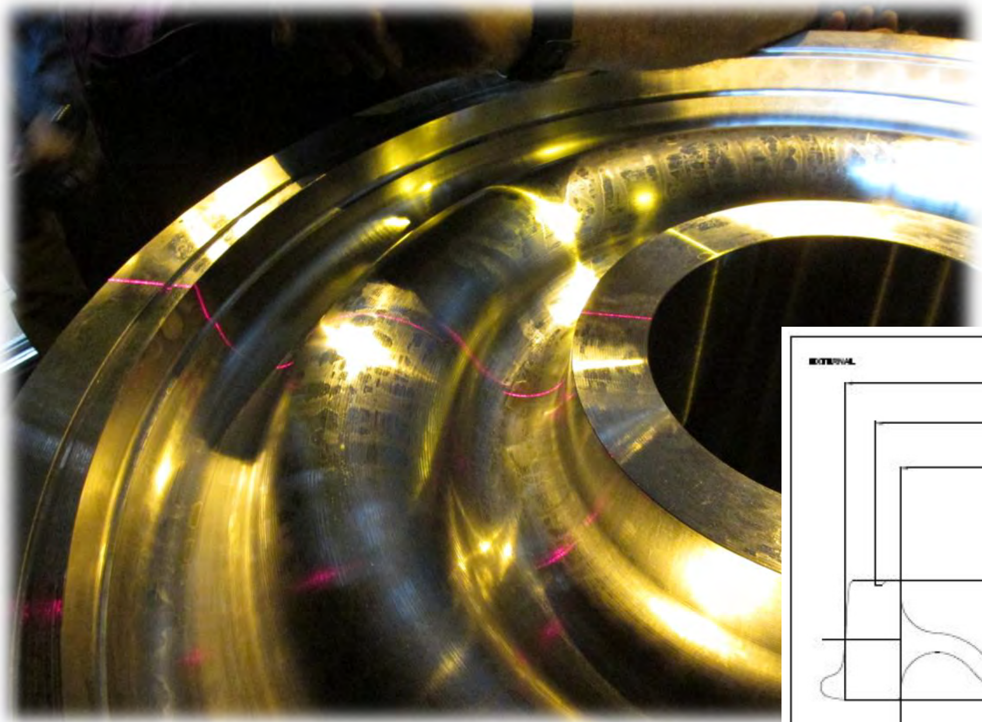
camea

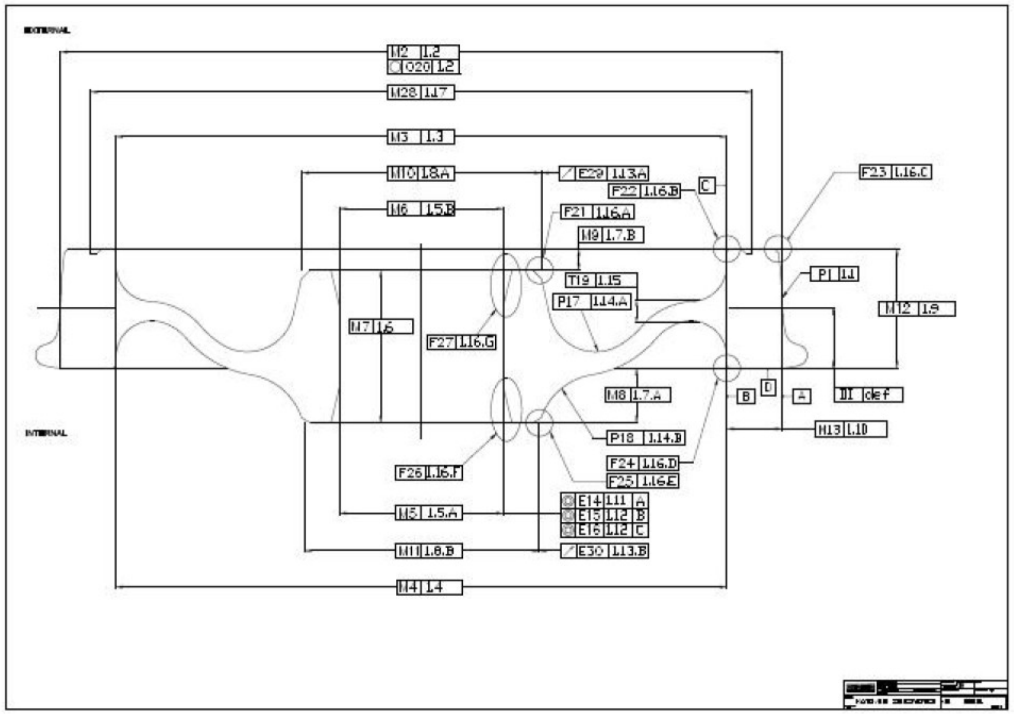
Inštalácie



camea

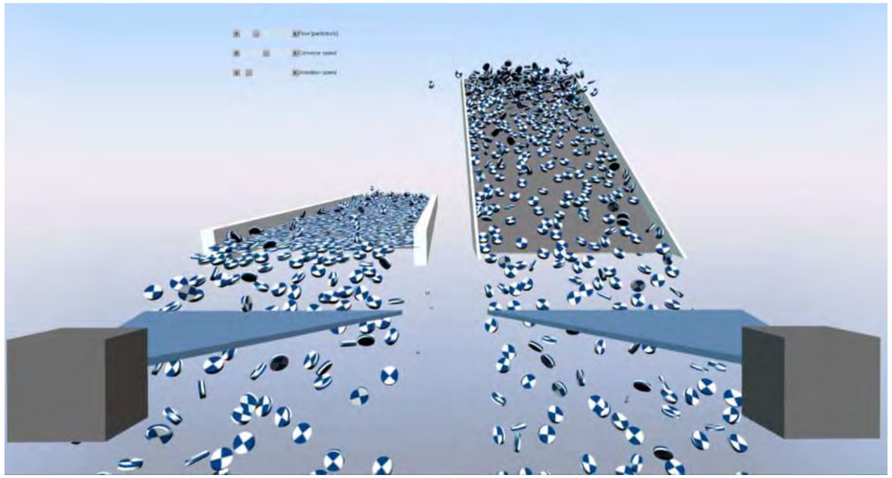
Meranie profilu železničného kolesa

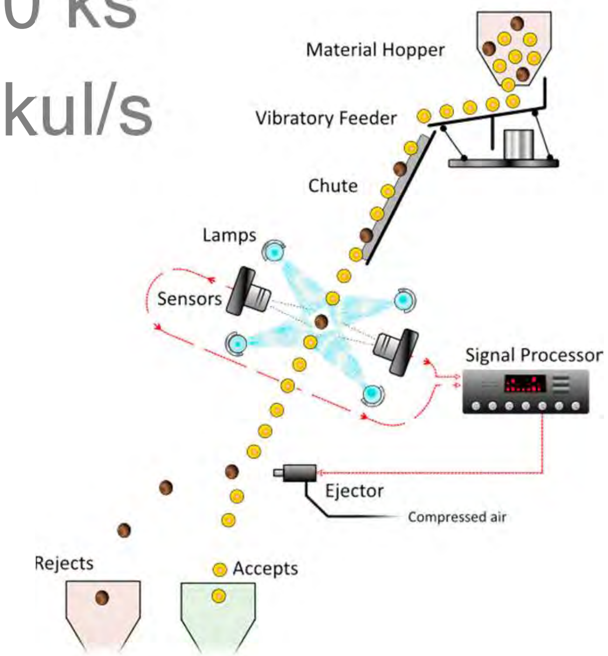




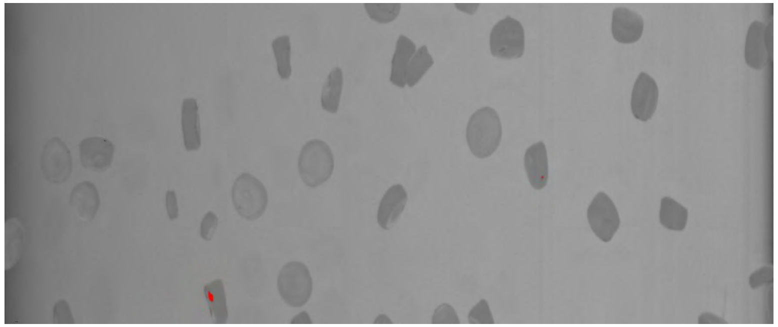
UniscanSORTER

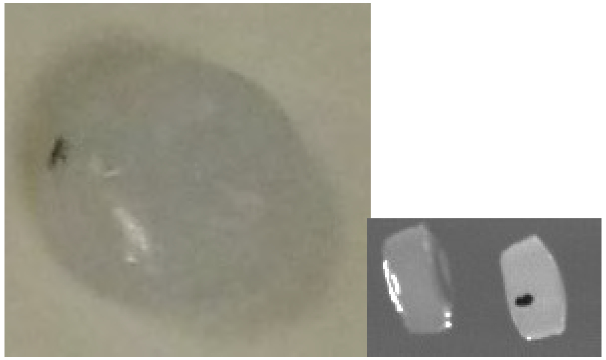
- Rozmery guľôčky: valec r = 2mm, h = 2
- Hmotnosť guľôčky: ro = 0,977g/cm3, m = 0,024g
- Počet guľôčok v 1t = 40.000.000 ks
- Pri rýchlosti 1,5 t/hod. = 16600 kul/s
- Rozlíšenie kamery 50um/px



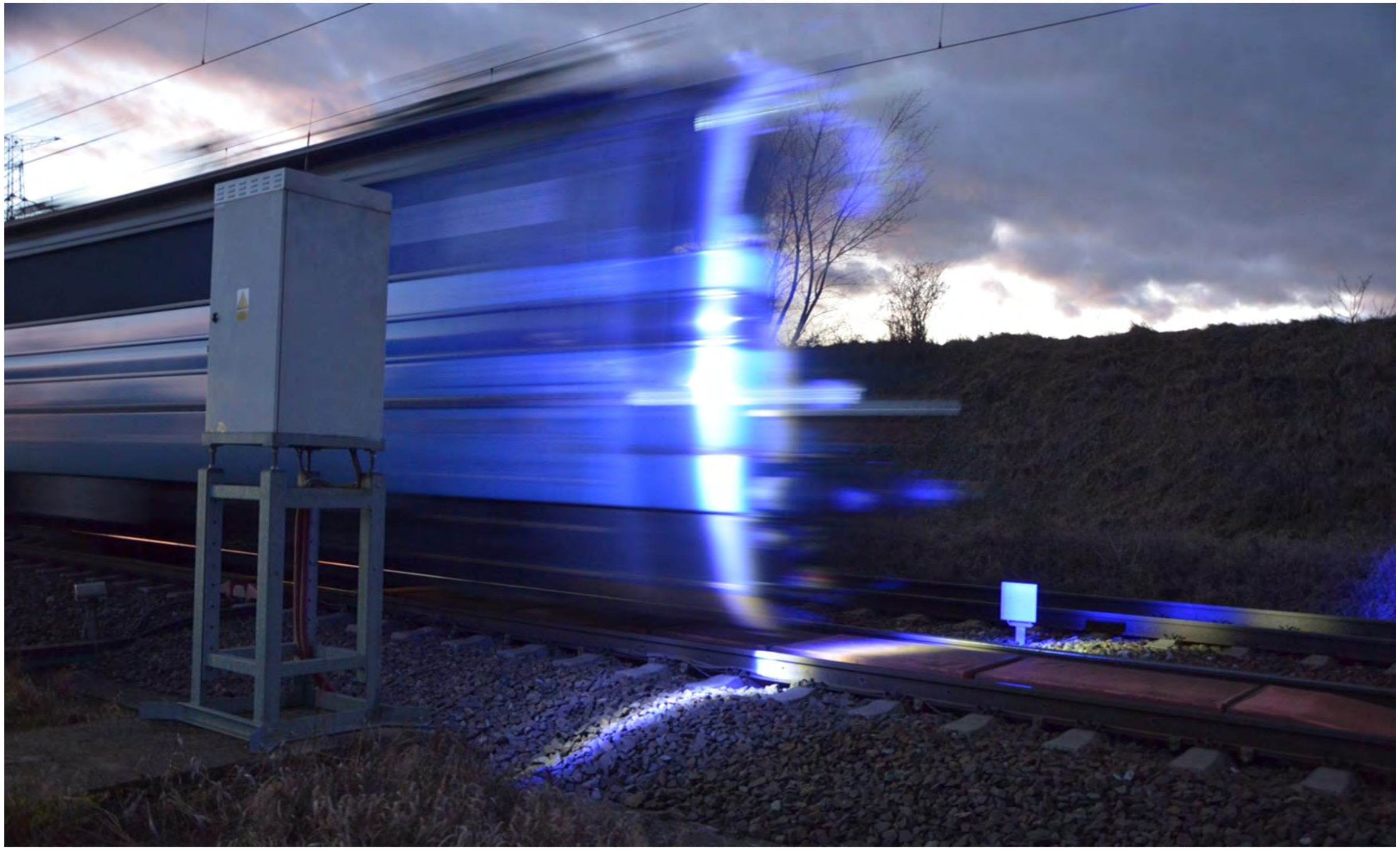


UniscanSORTER

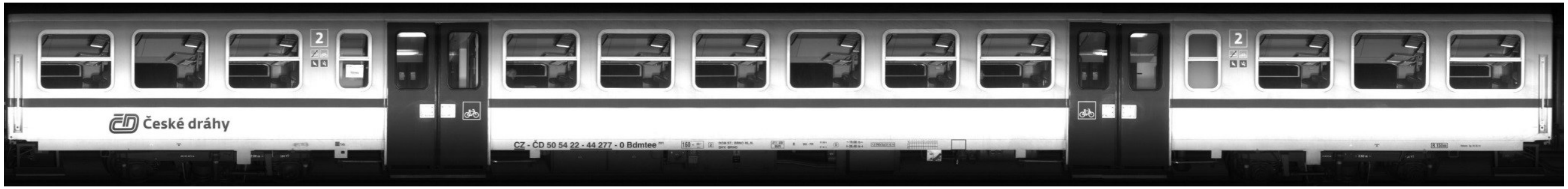




Unirail



Optické čítanie UIC kódov



Ďakujem za pozornosť.

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