

3rd INTERNATIONAL CONFERENCE **3D** MEASUREMENT AND IMAGING

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

MODERN CONTACTLESS MEASUREMENTS IN INDUSTRIAL PRACTICE

MODERNÉ BEZKONTAKTNÉ MERANIA V PRIEMYSELNEJ PRAXI

SEA
Agentúra pre vzdelanie a vedu

10th - 11th OCTOBER, 2018
ODOBORÁRSKA 21, BRATISLAVA

***Abstracts
and Presentations***
Abstrakty a prednášky

ABSTRACTS AND PRESENTATIONS

3rd INTERNATIONAL CONFERENCE **3D MEASUREMENT AND IMAGING** **MODERN CONTACTLESS MEASUREMENTS IN INDUSTRIAL PRACTICE**

10th-11th OCTOBER, 2018
ODOBORÁRSKA 21, BRATISLAVA

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GENERAL TRENDS IN COMPUTER VISION

Michael Ross ¹

¹ Allied Vision Technology

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3D MEASUREMENT AND IMAGING

*MODERN CONTACTLESS MEASUREMENTS
IN INDUSTRIAL PRACTICE*



SEEING THE BIGGER PICTURE -
GENERAL TRENDS IN COMPUTER VISION

Michael Ross, Sales Development Manager EMEA

HIGH-PERFORMANCE DIGITAL CAMERAS



Quality designed and made by Allied Vision

- In-house development and manufacturing
- Widest product range in the market for nearly all machine vision applications
- Cutting-edge digital technology
 - High resolution, high sensitivity
 - Visible and infrared spectrum
 - Large choice of standard interfaces

APPLICATIONS EXAMPLES

Industrial Inspection



Ziemann & Urban
Inspection of BMW
instrument panel
carriers

Healthcare & Medical



Carl Zeiss Meditec
Ophthalmologic
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

A GLOBAL PLAYER



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

Application and technology trends

LATEST APPLICATION TRENDS IN COMPUTER VISION

- Autonomous Systems (drones, service robots ...)



- Virtual / Augmented Reality



LATEST APPLICATION TRENDS IN COMPUTER VISION

- Security / Surveillance

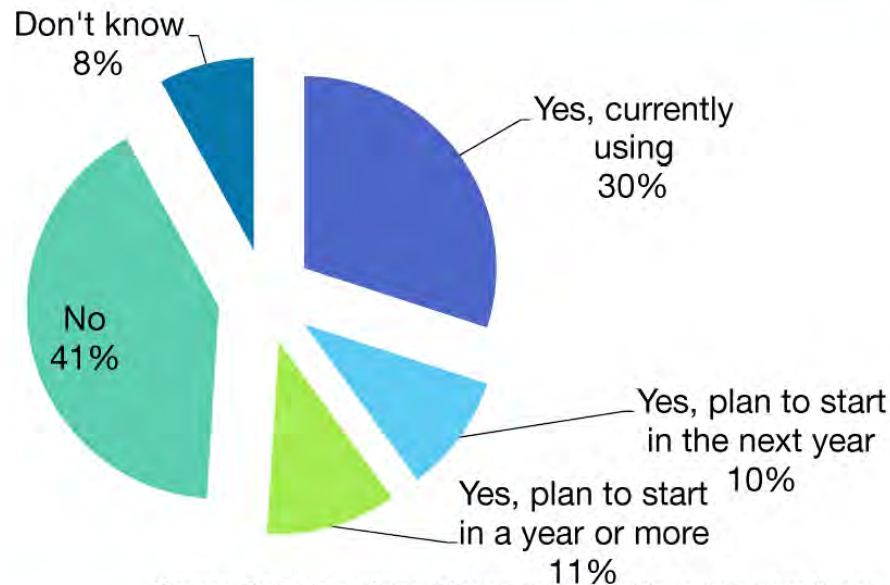


- New Retail concepts (vision based checkout, automated inventory and delivery, smart vision based theft protection ...)



EMERGING TECHNOLOGY TRENDS (TO ENABLE APPLICATION TRENDS)

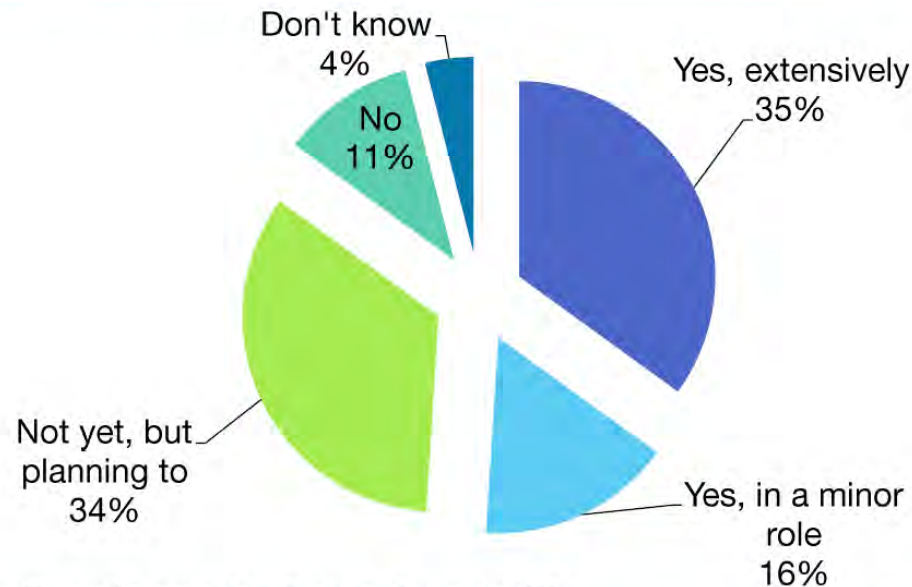
- 3D technologies: current use of 3D perception in products



Source: Embedded Vision Alliance, *Computer Vision Developer Survey*, 11/2017

EMERGING TECHNOLOGY TRENDS (TO ENABLE APPLICATION TRENDS)

- AI/neural networks: current use neural networks to perform computer vision functions



Source: Embedded Vision Alliance, *Computer Vision Developer Survey*, 11/2017

EMERGING TECHNOLOGY TRENDS (TO ENABLE APPLICATION TRENDS)

- Embedded vision -> separate presentation

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The slide displays a collection of logos for the lead sponsors of the Embedded Vision Summit 2018. The logos are arranged in a grid-like fashion. The sponsors include: Allied Vision (red 'A' logo), Intel (blue circular logo), Lattice Semiconductor (yellow and black logo), Synopsys (purple logo), Arm (blue logo), BDTi (blue logo), Cadence (black logo), Horizon Robotics (blue and white logo with Chinese characters), Novumind (green and blue logo with the tagline 'Making Things Think'), Qualcomm (blue logo), Xilinx (red and black logo), Aimotive (green logo), Luum (black logo), Luxoft (blue logo with a diamond shape), Nextchip (brown and blue logo), and NXP (orange and green logo). At the bottom of the slide, there is a blue bar containing the Embedded Vision Alliance logo, the copyright notice 'Copyright © 2018 Embedded Vision Alliance', and the page number '11'.

embedded VISION ALLIANCE

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11

The new BonitoPRO cameras

BONITOPRO AS A CAMERA FOR HIGH PERFORMANCE 3D APPLICATIONS



- // High Speed
- // High Resolution
- // High Performance
- // High Quality

BONITO PRO COAXPRESS CAMERA SERIES

- // Works with any Frame Grabber SDK
- // Mono, color and NIR version available
- // Very accurate triggering capability with real time behavior
- // No additional trigger cable or power supply needed
- **Application examples:**
 - **High speed and high resolution 3D imaging (stereo vision or structured light setup)**
 - Automated Optical inspection, e.g PCBs
 - Surface inspection, e.g. glass, flat panel display, printing etc.
 - Aerial surveillance



CXP-6

BONITO PRO – MODEL AND FEATURE OVERVIEW

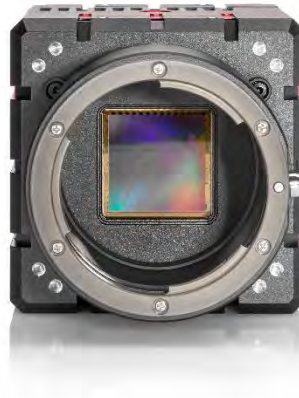
Model	Sensor	Type	ADC [bits]	Resolution	Pixel Size [μm]	Sensor Size	Frame Rate [fps]	Order Code
X-1250B/C/NIR	PYTHON 12k	CMOS	10	4096 × 3072	4.5 × 4.5	4/3"	142.6	02-2880D/02-2881D/02-2882D
X-2620B/C/NIR	PYTHON 25k	CMOS	10	5120 × 5120	4.5 × 4.5	APS-H	79.7	02-2884D/02-2885D/02-2886D

CXP-6

High Ambient Operating
Temperature Range

F/EF/M42/M58 Mount

Canon EF lens control



Power over CoaXPress (PoCXP)

Trigger over CoaXPress (ToCXP)

Opto isolated Inputs/Outputs

Temperature monitoring

WHAT IS COAXPRESS?

The CoaXPress Interface



- // Developed for high speed image data transmission in Machine Vision applications
- // Also suitable for other imaging applications and high speed data transmission in other fields
- // First demonstrated in 2008, officially released as a standard in March 2011
- // Japan Industry Imaging Association (JIIA) regulates the standard and overlooks compliancy
- // Up to 6.25Gbps over single coax cable → 25Gbps using four cables (CXP-6 Quad)
- // Long cable lengths possible without repeaters/hubs. Maximum cable lengths bit rate dependant
- // **CoaXPress frame grabber always required**

TESTED FRAME GRABBERS

- Euresys Coaxlink Quad G3
- Active Silicon FireBird Quad CXP-6
- Teledyne Dalsa Xtium-CXP PX8
- Silicon Software microEnable 5 ironman
- Bitflow Cyton-CXP
- ... More will be tested later (Aval Data, Matrox, Kaya)
- **Should work with all CoaXPress standard certified frame grabbers**



BONITOPRO AS A CAMERA FOR HIGH PERFORMANCE 3D APPLICATIONS



Thank you very much!

Michael Ross

Sales Development Manager EMEA

michael.ross@alliedvision.com

Allied Vision Technologies GmbH

www.alliedvision.com

ROBOTIC 3D VISION TECHNOLOGIES WITH GOCATOR 3D SMART SENSORS

Edwin Popp ¹

¹ LMI Technologies

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3D MEASUREMENT AND IMAGING

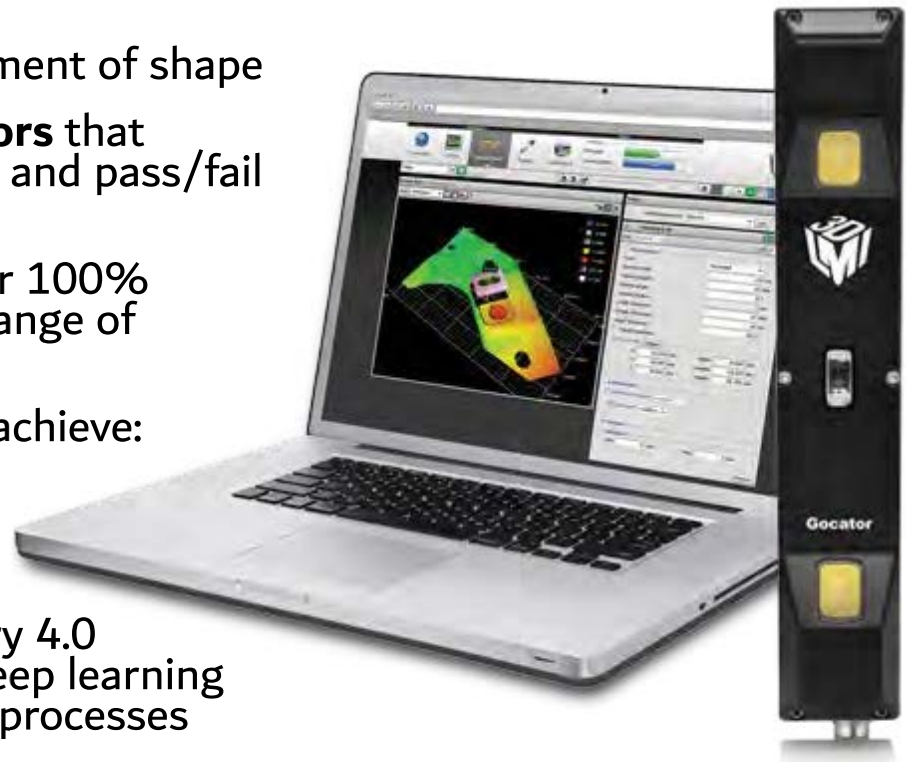
*MODERN CONTACTLESS MEASUREMENTS
IN INDUSTRIAL PRACTICE*

**ROBOTIC 3D VISION TECHNOLOGIES
WITH GOCATOR 3D SMART SENSORS**

Edwin Popp, Territory Manager, LMI Technologies

3D SCANNING AND INSPECTION

- 3D technology enables the measurement of shape
- We design and build **3D smart sensors** that perform 3D scanning, measurement, and pass/fail decisions in an **all-in-one package**
- Our smart sensors are used inline for 100% scanning and inspection in a broad range of markets and applications
- Smart sensors enable customers to achieve:
 - Automation
 - Optimization
 - Quality control
- Smart sensors are the key to Industry 4.0 delivering actionable data to drive deep learning systems for dynamic manufacturing processes



QUICK FACTS



Owned by TKH Group

- Dutch public company (AMS: TWEKA)
- €1.35B annual revenue
- Focused on vision & security, communication, connectivity and production systems

39+ years experience

1978 – Present



*One of our
Selcom
displacement
sensors
developed in the
1970s*

100+ patents

and 280+
employees



110,000+ sensors

in the field



GLOBAL PRESENCE



3D SCANNING AND INLINE INSPECTION

- HIGH SPEED, HIGH ACCURACY 3D SENSORS

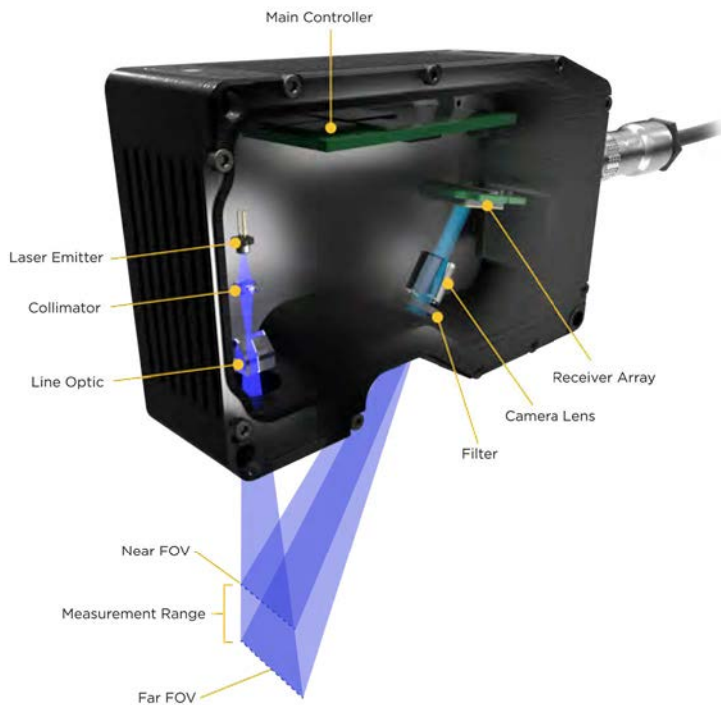


- HIGH PERFORMANCE 3D MEASUREMENT ALGORITHMS

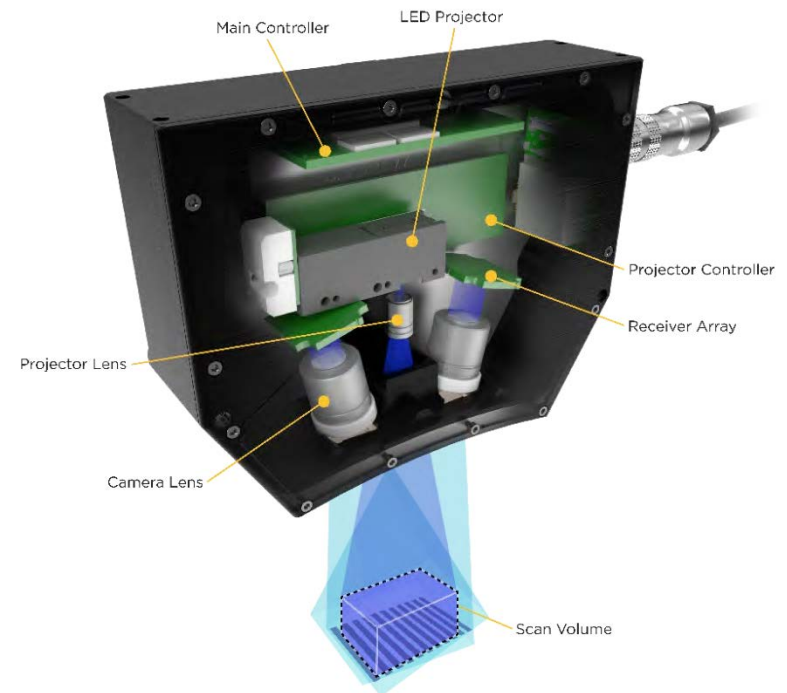


TWO 3D TECHNOLOGIES FOR METROLOGY-GRADE INSPECTION

- LASER (TRIANGULATION) PROFILERS

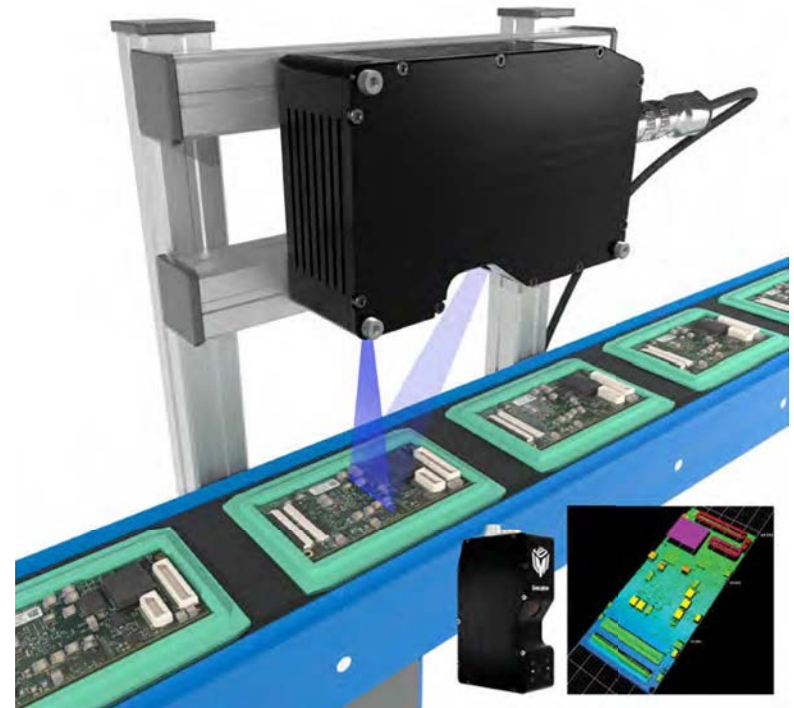
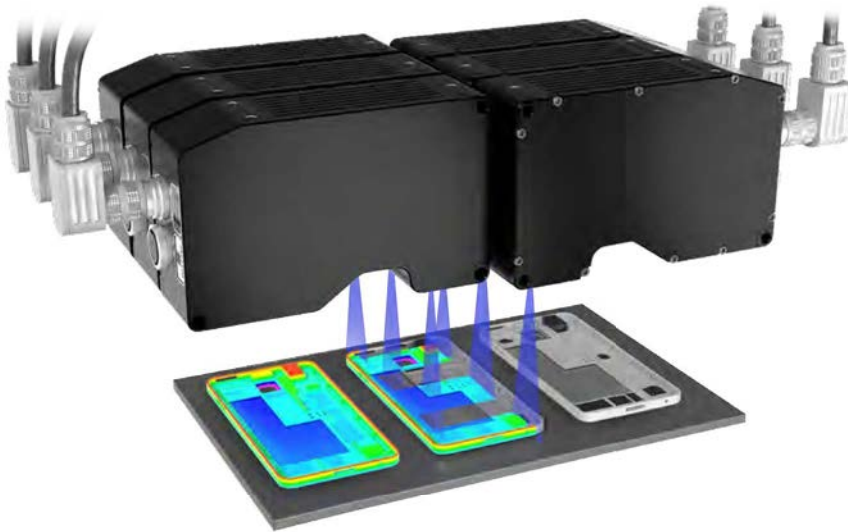


- STRUCTURED LIGHT SNAPSHOT SENSORS



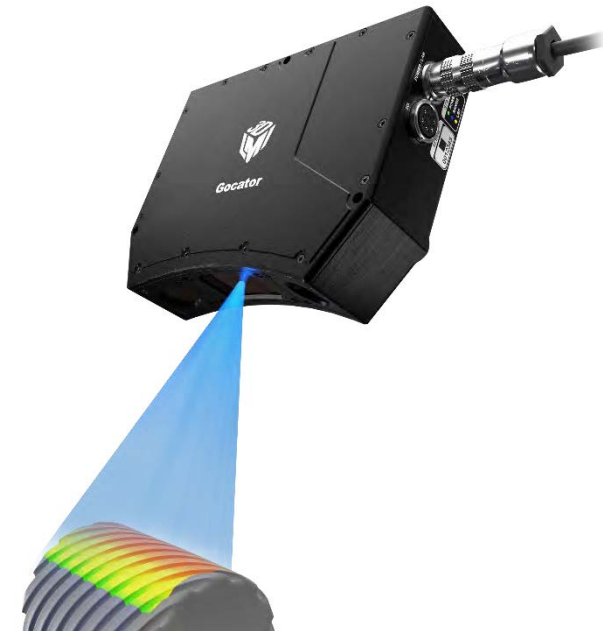
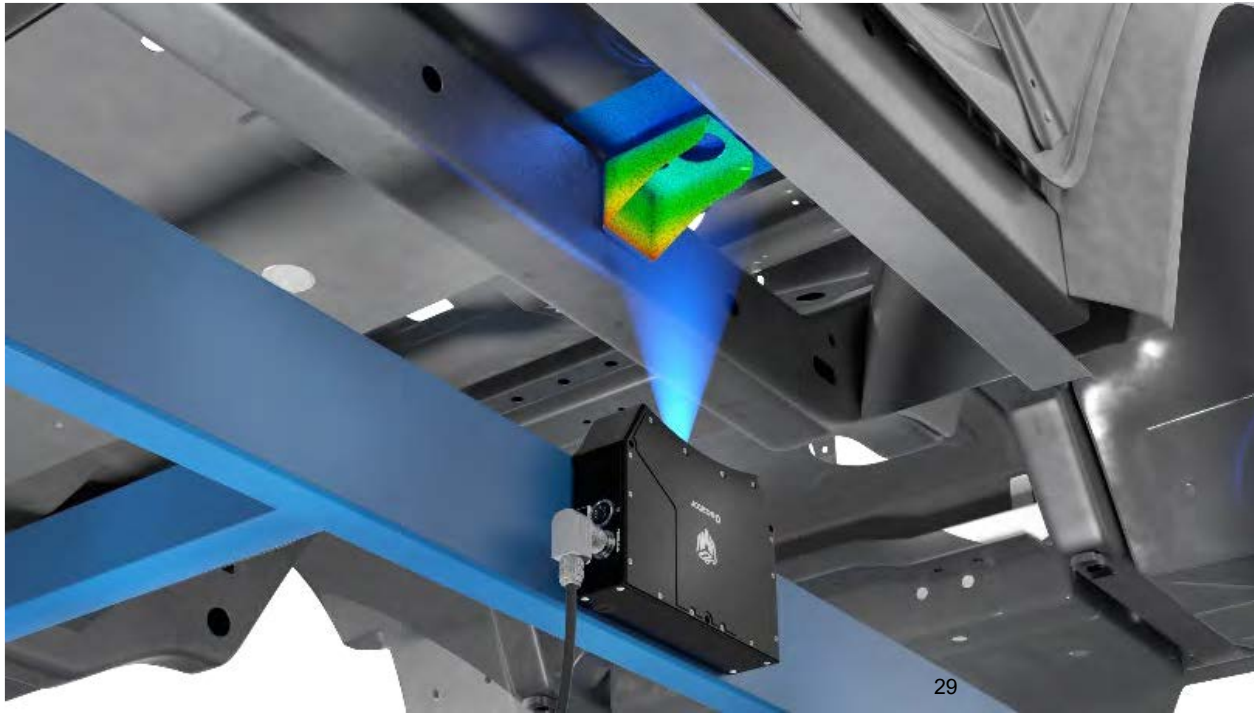
GOCATOR LASER PROFILERS

- Gocator point and line profile sensors can inspect any moving target inline with resolutions down to 6 μm and sampling speeds up to 32 kHz



GOCATOR SNAPSHOT SENSORS

- Gocator stereo snapshot sensors generate full-field 3D point clouds with a single scan trigger to inspect any target with start/stop motion in an inline process



DRIVERS OF VISION-GUIDANCE SYSTEMS

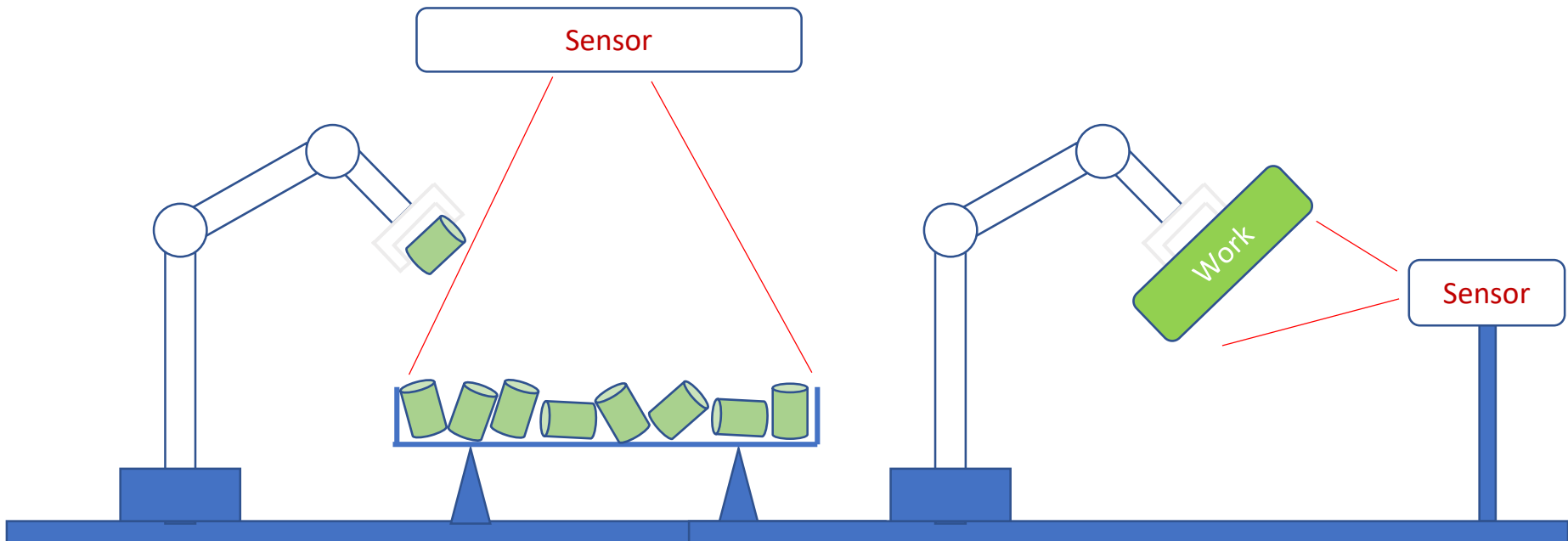
- Need to reduce labor costs
- Reduced fixture and tooling cost
- 3D vision sensors and greater processing power
- Robust image-processing software and algorithms
- Guidance increases applications spectrum for robots



ROBOTIC 3D VISION

1. Mounted on Frame

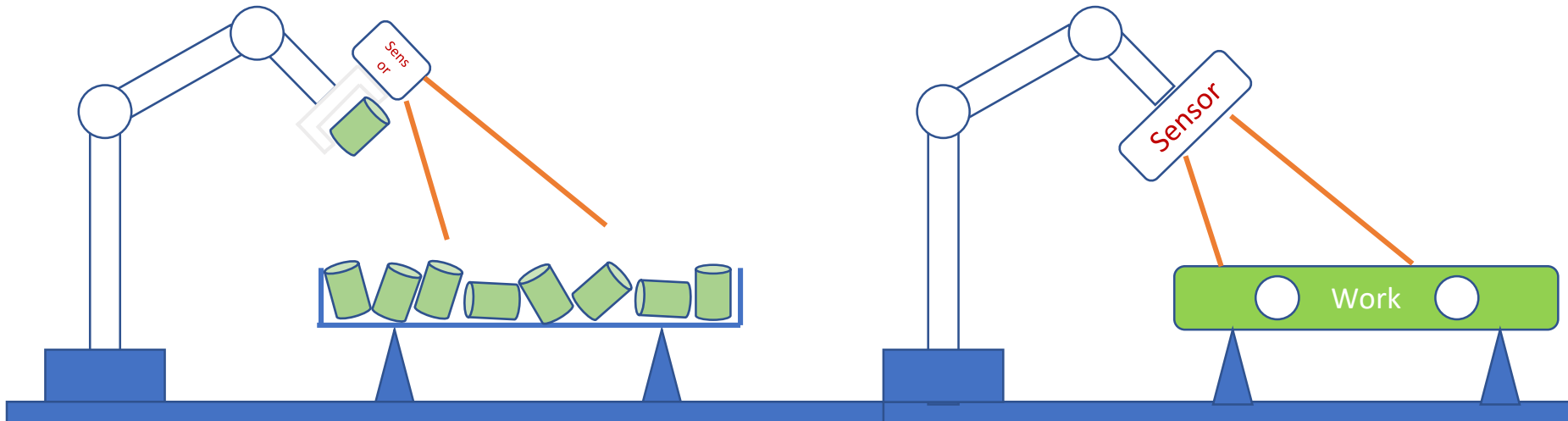
- On frame scanning pick and place system: scan through on frame sensor, and let the robotic arm pick up the pieces.
- Key dimensions of the pieces mounted on a robotic arm will be inspected by sensor. Inspection and sorting will be completed during loading and unloading period.



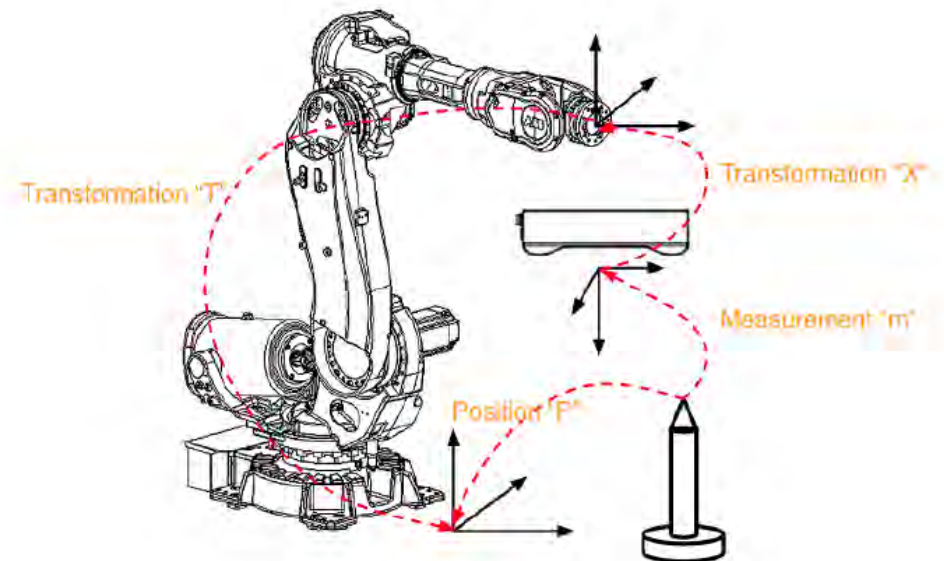
ROBOTIC 3D VISION

- Mounted on Robotic Arm

- On hand sensors perform real-time positioning, and realize real-time integration such as pick-and-place, welding tracking, positioning and installation
- A large object can be inspected by a robotic arm mounted with the sensor. While ensuring the accuracy, it also breaks through the limitations of sensor measurement, and achieves complete inspection for large objects.



ROBOT HAND-EYE CALIBRATION



$$P_1 = [T_1] \cdot [X] \cdot m_1;$$

$$P_2 = [T_2] \cdot [X] \cdot m_2;$$

.....

$$P_n = [T_n] \cdot [X] \cdot m_n$$

CHALLENGES OF ROBOTIC 3D VISION

Communication

- Different communication protocols due to variety of robots
- Only I/O protocol available communicating with robot, and cannot achieve more advanced communication
- Multiple signals can not be outputted
- Communicate via the host computer

Calibration

- Need to start with camera calibration and cannot be calibrated directly with the robot
- The sensor itself does not have a mature calibration algorithm
- Calibration error cannot be guaranteed
- Calibration via PC software

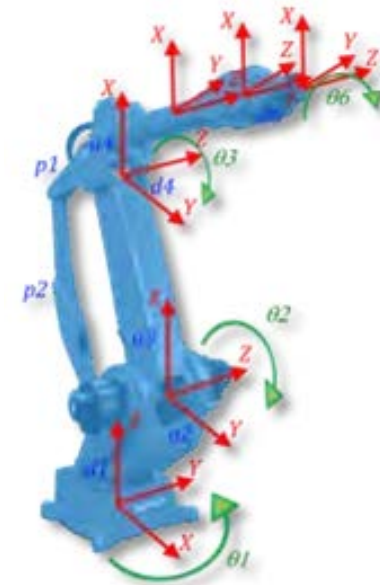
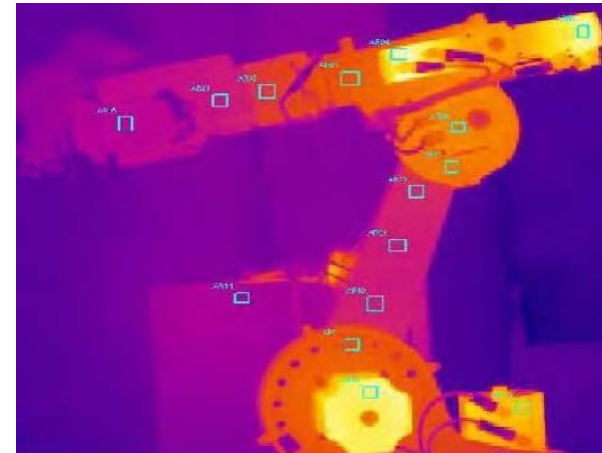
Algorithm Development

- Non-smart sensors are not able to measure size
- No rich algorithms and need to rely on third party software
- Not support further development
- Need extra PC and software, which will increase the cost

CHALLENGES OF ROBOTIC 3D VISION

Temperature Compensation

- Most industrial robots consist of aluminum alloys which are subject to the temperature changes
- Most robot calibration depends on the repeatability of the robot itself, such as robot welding, assembly and inspection, etc.
- Compensation of robotic error caused by outside temperature changes is particularly important, temperature compensation is a real-time monitoring robot tool center point (TCP) process with temperature changes.
- Based on monitoring of change value and the parameters of robot DH model, the corresponding DH model parameter settings can be calculated to compensate for the variation of TCP with the temperature changes



MORE THAN JUST A SENSOR



Gocator is a complete inspection platform – combining 2D and 3D data **acquisition**, **measurement** tools and control logic supported by industry-first **customization tools** running within a web browser **user experience**.

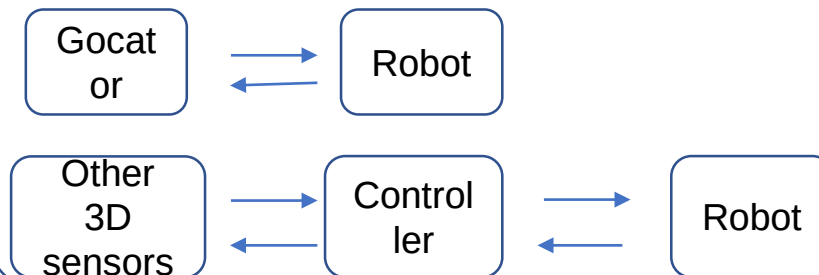
THE GOCATOR ADVANTAGE

Communication

- Different communication protocols due to variety of robots
- Only IO protocol available communicating with robot, and can not achieve more advanced communication
- Multiple signals can not be output
- Communicate via the host computer

Gocator Solution

- Gocator all-in-one 3D smart sensor, no need host computer or controller, support for “plugging into” PLCs or robot controllers
- Gocator gives you the flexibility to simultaneously output data and decisions to a wide variety of I/O
- Allows you to easily communicate with your existing hardware including PLCs and robot controllers via TCP/IP or Ethernet IP protocols
- Conduct direct communication with robots



THE GOCATOR ADVANTAGE

Calibration

Gocator Solution

- Need to start with camera calibration and cannot be calibrated directly with the robot
- The sensor itself does not have a mature calibration algorithm
- Calibration error can not be guaranteed
- Calibration via PC software

- Factory pre-calibrated, and the user only needs to consider the coordinate conversion between the robot and camera
- Through direct communication, robot calibration, without other host computer or software can be realized
- A mature calibration algorithm that can be used to calibrate sensor and robot
- Gocator is a highly accurate sensor, is far greater than the repetitive positioning accuracy of the robot itself, which can ensure minimize the calibration error even realize the correction of the robot itself through specific method (such as robot origin error and the error caused by the temperature change or abrasion)
- Performing robot hand eye calibration can be available through third party software

THE GOCATOR ADVANTAGE

Algorithm Development

- Non-smart sensors are not able to measure size
- No rich algorithms and need to rely on third party software
- Not support further development
- Need extra PC and software, which will increase the cost

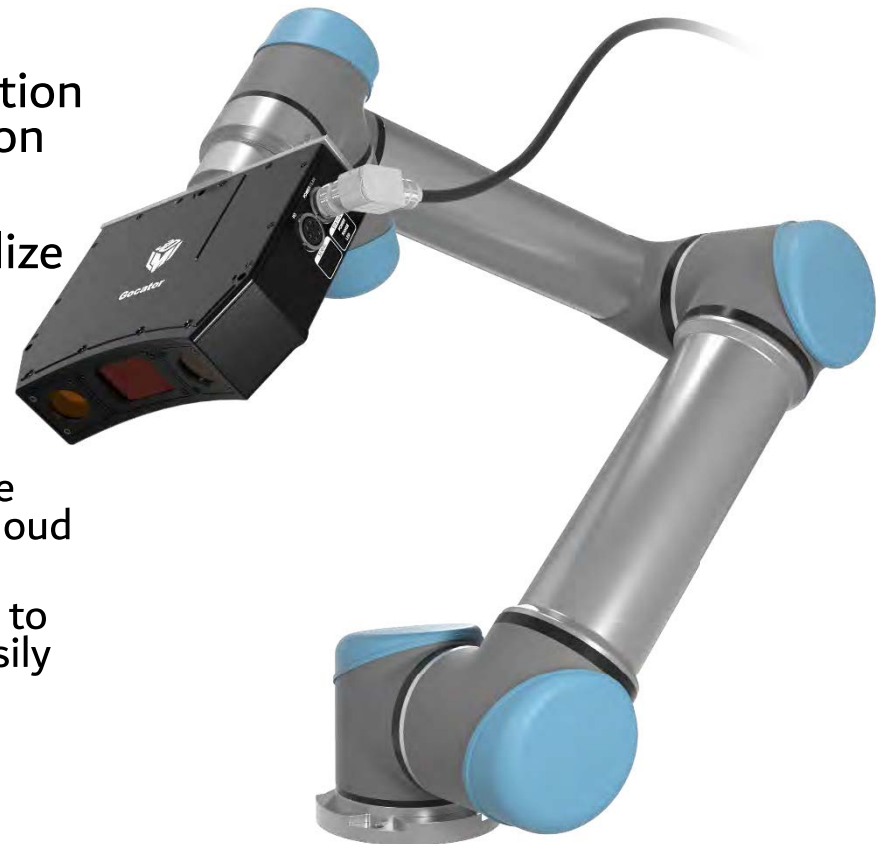
Gocator Solution

- Rich SDK and Gocator Development Kit (GDK) tools, and free open to users
- No need for third party software, and can be integrated into the sensors. No other hardware required.
- Standard tools within Gocator are able to achieve many measurements out of the box and are a result of extensive

THE GOCATOR ADVANTAGE

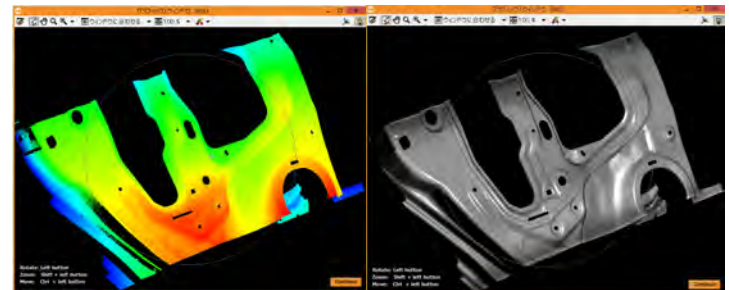
Temperature Compensation

- The key of robot temperature compensation is to precisely determine the TCP variation caused by the temperature change
- Gocator snapshot sensors can easily realize the calibration of temperature compensation:
 - The 3D point cloud data can be obtained without any movement
 - DLP projection and stereo cameras acquire high accuracy and high density 3D point cloud data
 - All-in-one design, compact footprint, easy to use without any controller and PC, and easily integrated into the robot arm
 - Rugged IP67 construction for harshest industrial environments
 - Build-in temperature compensation



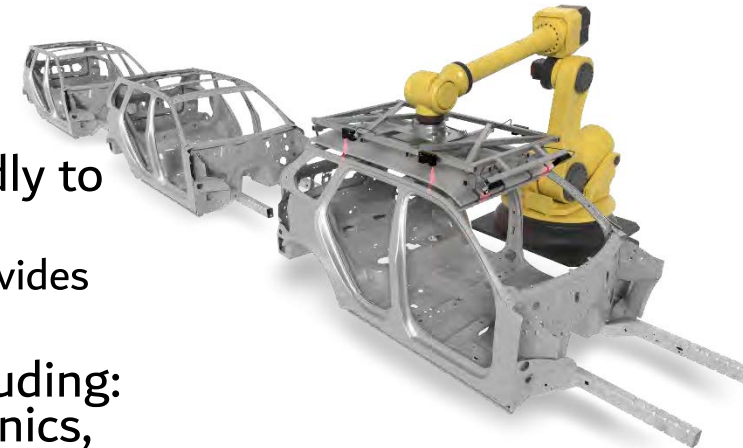
FLEXIBLE AUTOMATION

- The ability for a robot to be quickly and easily re-tasked on-the-fly
 - Requires the solution to have the ability to sense, think, and act
 - Ultimately adapt to changes in manufacturing
 - Ex) multi-model production
- Size and weight is critical when mounted on robots
- Gocator 3210:
 - 100 x 154mm Scan view
 - IP67, dust-proof and water resistant
 - Shock and vibration resistance
 - Built-in 3D measurement tools



BENEFITS OF ROBOT VISION GUIDANCE

- Normally, a robot moves blindly but repeatedly to a known position within the arm's reach
 - With robot vision guidance, machine vision provides the robot with a position for its motion
- Widespread use across many industries, including: automotive, pharmaceutical, medical, electronics, and food and beverage
- Switching between products and batch runs is software controlled and very fast, with no mechanical adjustments.
- High residual value of the system, even if production is changed
- High machinery efficiency, reliability, and flexibility
- Reduces manual labor/work costs



CASE STUDY - AUTOMOTIVE ROBOTIC VISION GUIDANCE



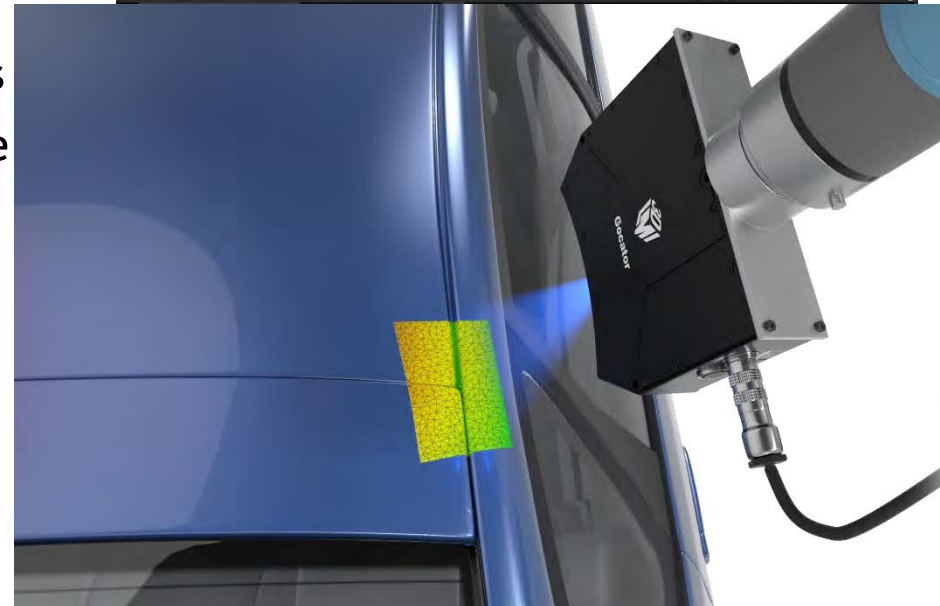
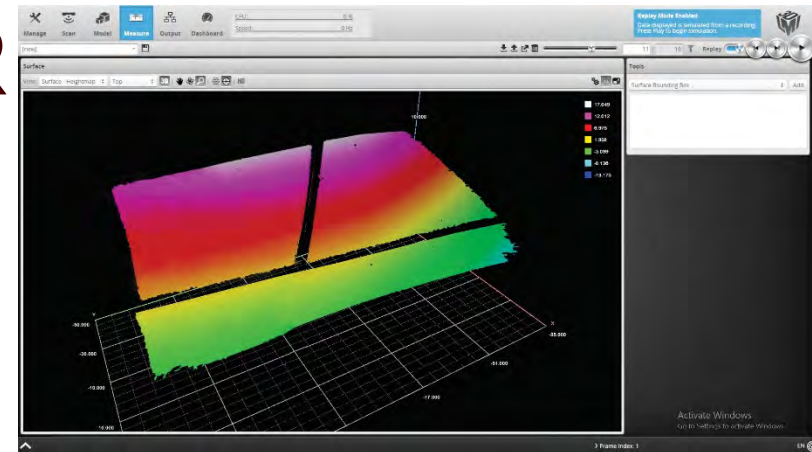
Vision-guidance for accurate robotic insertion of windshields, roofs, and rear windows

- Data will be sent to robot
- The robot carries the cover to the roof opening and near the windshield opening, then measures position
- Make the best fit for the opening and top or measurements, and calculate final TCP of 6 degrees of freedom
- Weld the roof to the roof opening
- Measure the final roof fit dimensions, such as gap & flush
- Challenges solved with Gocator:
 - Part variability
 - Environmental conditions (vibration of machine parts, lighting, temperature) not a concern with 3D sensors



GAP & FLUSH INSPECTION WITH SNAPSHOT SENSOR

- Snapshot sensors are able to measure multiple gap & flush features within a single field of view
- 3D surface data is cross-sectioned and measured for multiple profile views
- Built-in measurement tool
- Robot moves sensor to key locations
- Exposure modification allows for use on all vehicle colors
- Result of measurement:
 - Correct and error proof any build problem
 - Reduce unexpected cost in repairing misassembled panels
 - To reduce waste from discarding damaged panels due to fit problems



FORENSIC DOCUMENT EXAMINATION – 3D RECONSTRUCTION OF CROSSING LINES

Ing. Adriana Jabconová¹, RNDr. Bohumil Bohunický²

¹ Kriminalistický a expertízny ústav policajného zboru

² KVANT spol. s r.o.

Abstract

A collection of state-of-the-art analytical methods of optical microscopy, stereoscopy and electron microscopy were applied to set of simulated and real cases of line crossings. The processes were evaluated and compared. In the results we present suitability of each method for each different type of line crossing.

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FORENSIC DOCUMENT EXAMINATION 3D RECONSTRUCTION OF CROSSING LINES

Ing. Adriana Jabconová, Kriminalistický a expertízny ústav PZ
RNDr. Bohumil Bohunický, KVANT, spol. s r. o.

KRIMINALISTICKÉ SKÚMANIE DOKUMENTOV

- Kriminalistické skúmanie dokumentov je odvetvie kriminalistiky, ktoré sa zaoberá súdnoznaleckým technickým skúmaním dokumentov s cieľom overiť ich pravosť, autenticitu, zistiť ich pôvod a zdroj.
- Skúmaním sa tiež zisťuje spôsob ich vyhotovenia, analyzujú sa materiály a zariadenia použité na ich vyhotovenie.
- Ide o skúmanie sporných dokumentov, u ktorých vznikla pochybnosť o ich pravosti, pôvode, spôsobe vyhotovenia.
- Cieľom preskúmania či posúdenia sporných dokumentov je potvrdiť alebo vylúčiť tieto pochybnosti.

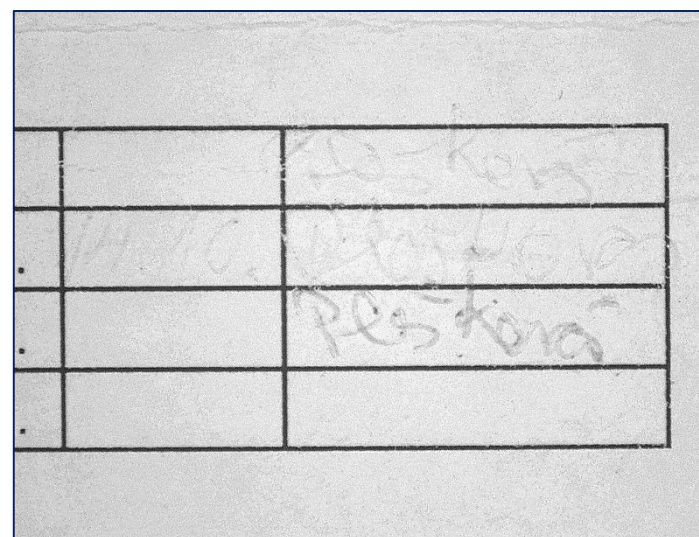
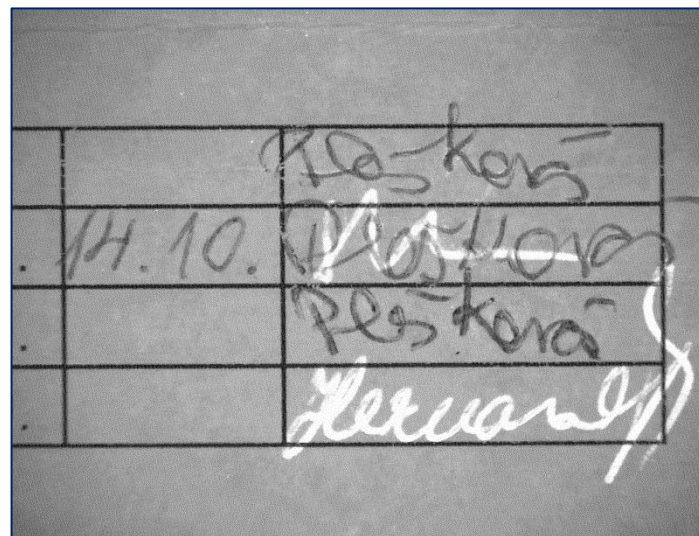
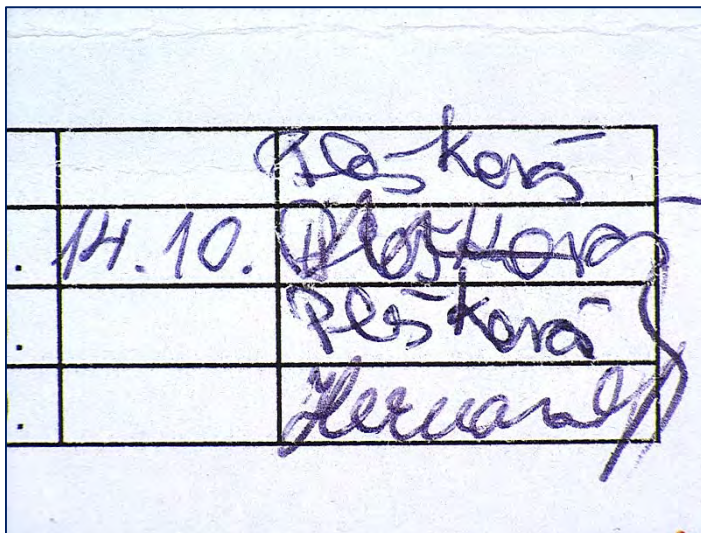
KRIMINALISTICKÉ SKÚMANIE DOKUMENTOV

- skúmanie dokumentov všetkého druhu: úradných a neúradných listín, účtovných a bankových listín, fotokópií, identifikačných dokladov, preukazov, dokladov k motorovým vozidlám, skúmanie bankoviek, cestovných a platobných šekov, e-koliek a iných cenín, tlačív a tlačovín a ich komponentov, anonymných zásielok a pod.
- antedatovanie a postdatovanie písomností
- identifikácia a zviditeľňovanie odstránených, dopísaných, prepísaných a skrytých údajov
- zisťovanie technického falšovania dokumentov a neoprávneného zásahu do ich celistvosti
- skúmanie stotožňovanie reprodukcii/kópií dokumentov
- skúmanie predmetov, ktoré sa k dokumentom vzťahujú: skúmanie písacích prostriedkov, reprodukčných zariadení a ich náplní, odtlačkov pečiatok a samotných pečiatok, pečatenia listín, razby, nitov a skôb, papierového/plastového podkladu, ochranných fólií, hologramov, obalov, šitia, a pod.,
- skúmanie perforácií, strihov, rezných a tržných hrán na listinách a pod.,
- skúmanie znehodnotených dokumentov - skartovaných, spálených, zhnitých, inak znehodnotených

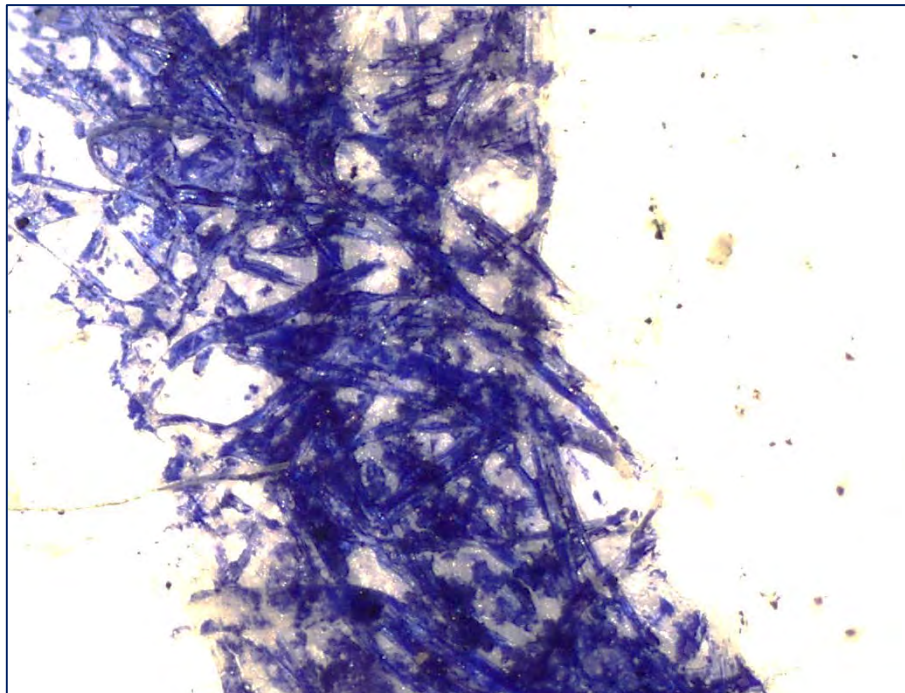
KRIMINALISTICKÉ SKÚMANIE DOKUMENTOV

- zisťovanie časovej postupnosti/poradia vzniku záznamov
- križujúce/prelínajúce sa línie vyhotovené kombináciou rôznych záznamových prostriedkov a substancií:
 - písací prostriedok (atrament, pasta, gél...)
 - počítačová tlačiareň, písací stroj (atrament, toner, farbivo pásy..)
 - pečiatka (pečiatková farba)

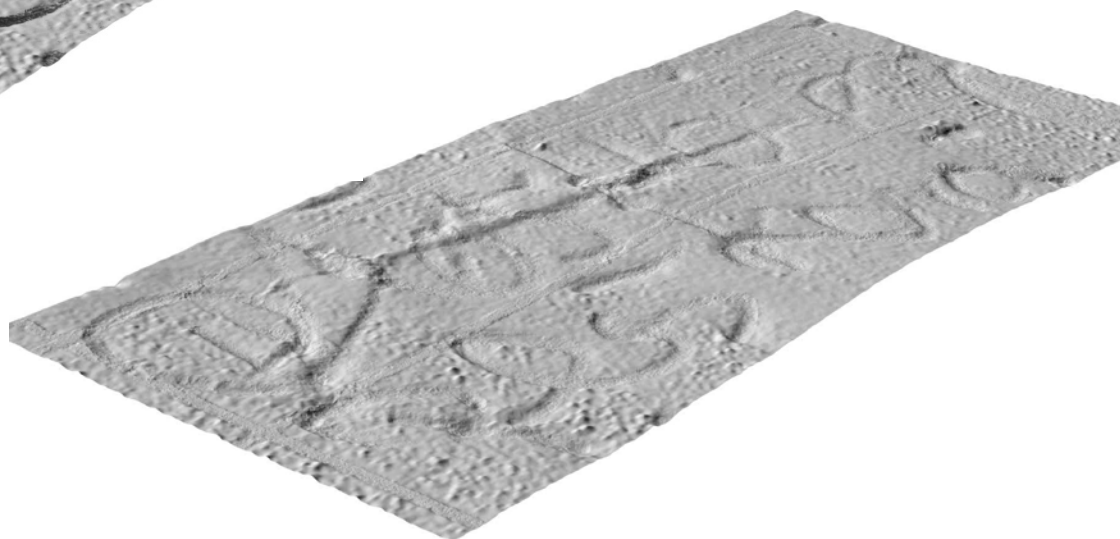
PASTA - PASTA



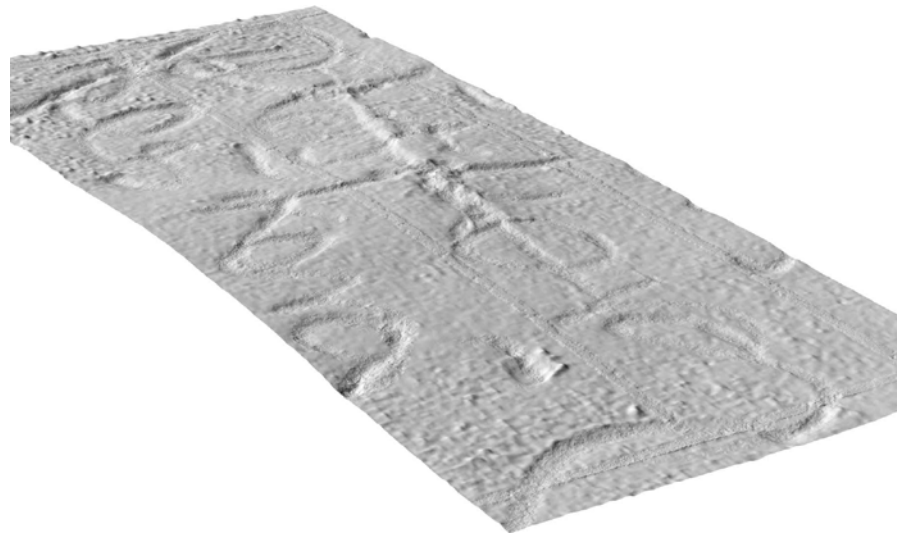
PASTA - PASTA



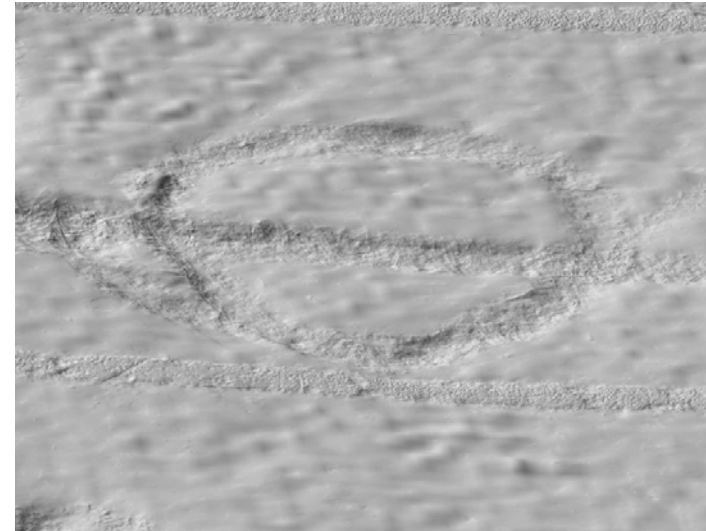
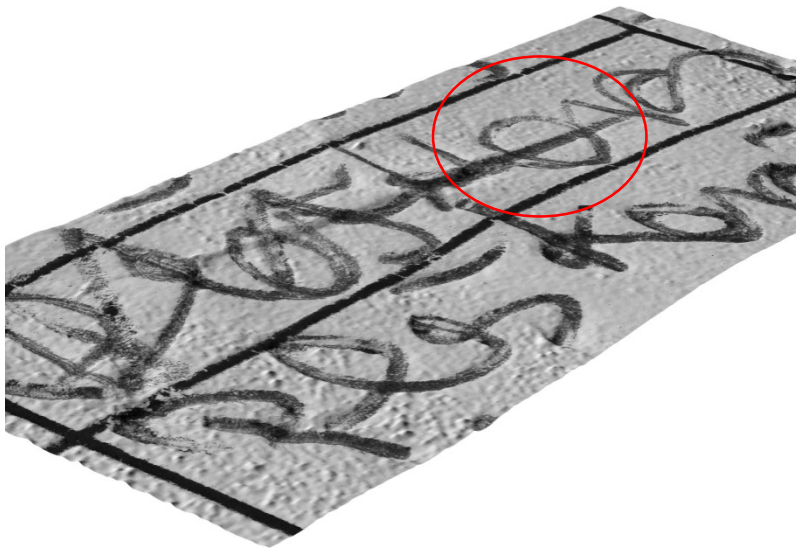
PASTA - PASTA



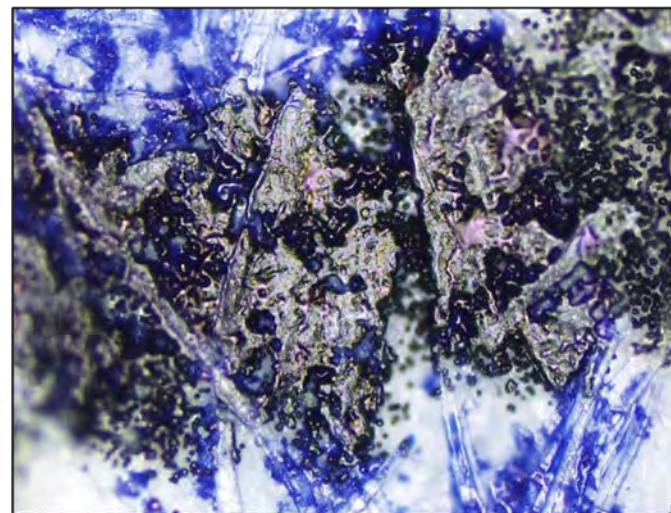
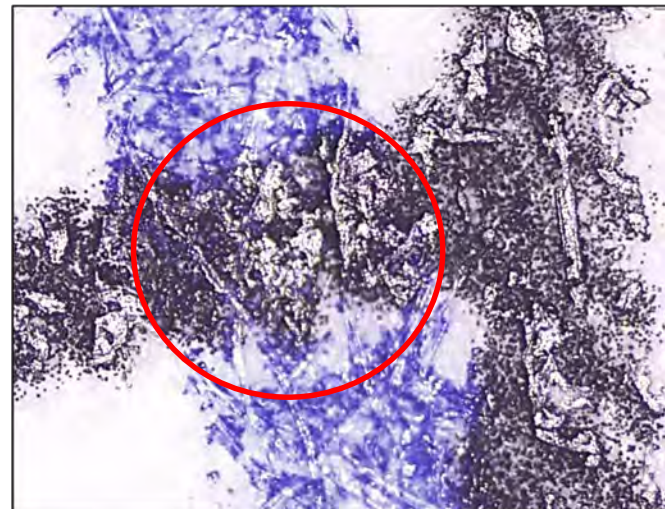
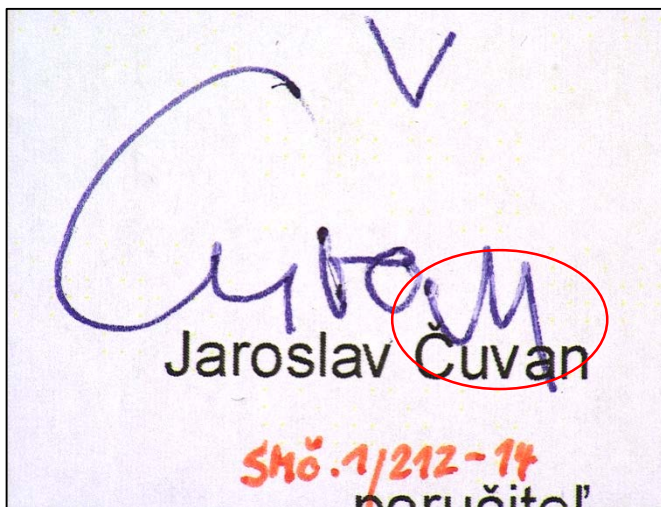
PASTA - PASTA



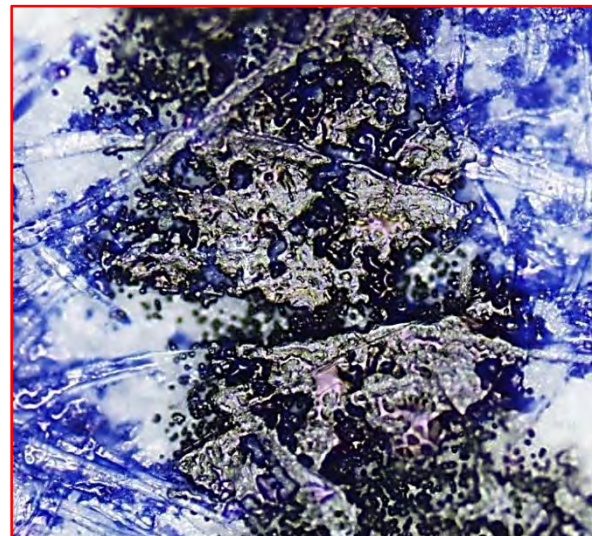
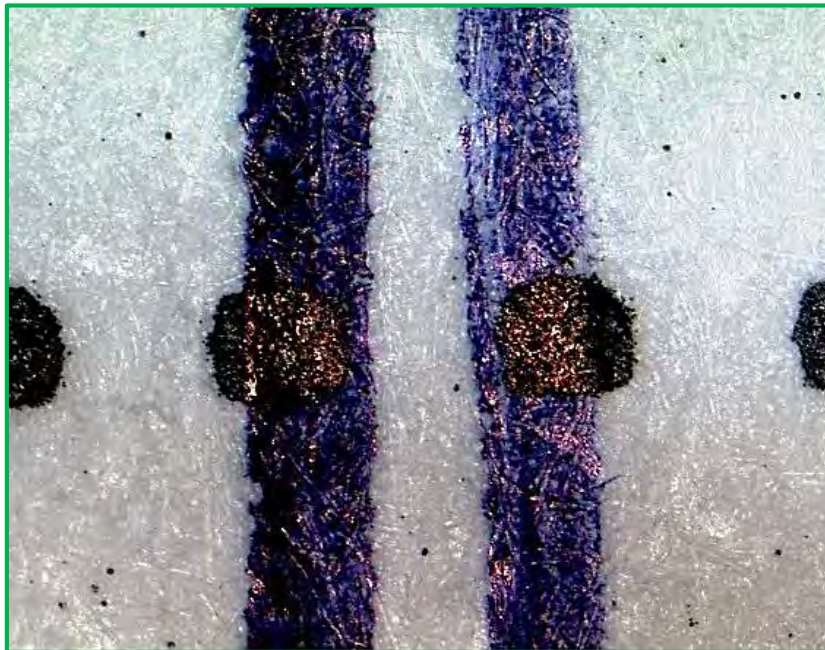
PASTA - PASTA



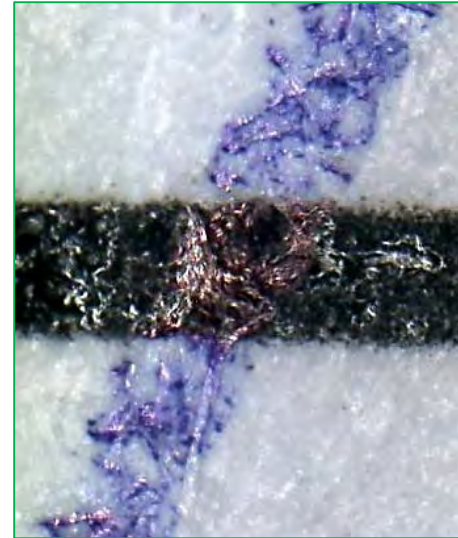
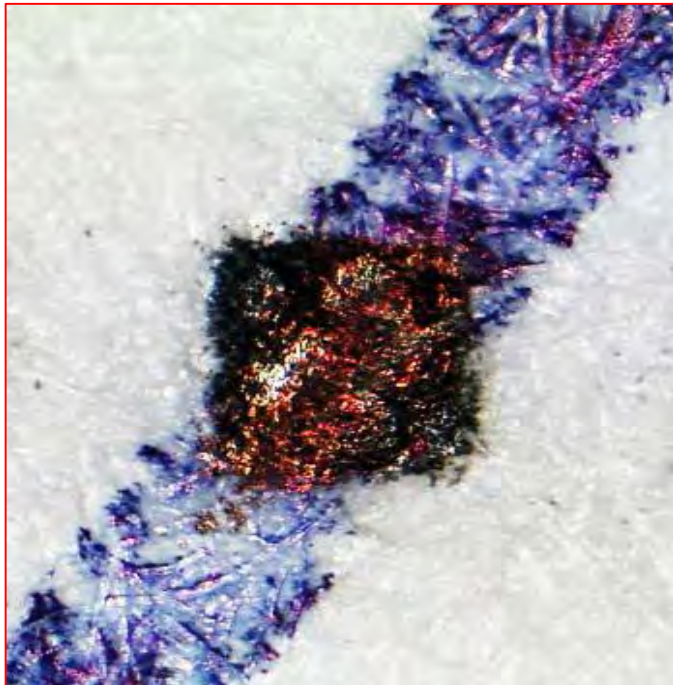
TONER - PASTA



TONER - PASTA



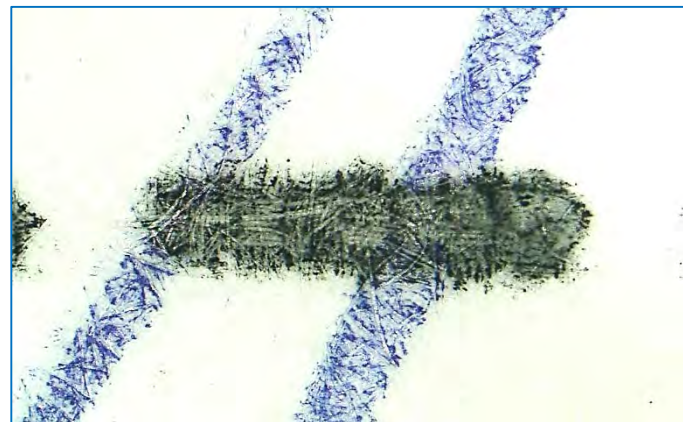
TONER - PASTA



TONER - GÉL



PASTA - SUBSTANCIA PÁSKY PÍSACIEHO STROJA



„PHYSICAL-CHEMISTRY STUDY OF CROSSED LINE INTERSECTION“

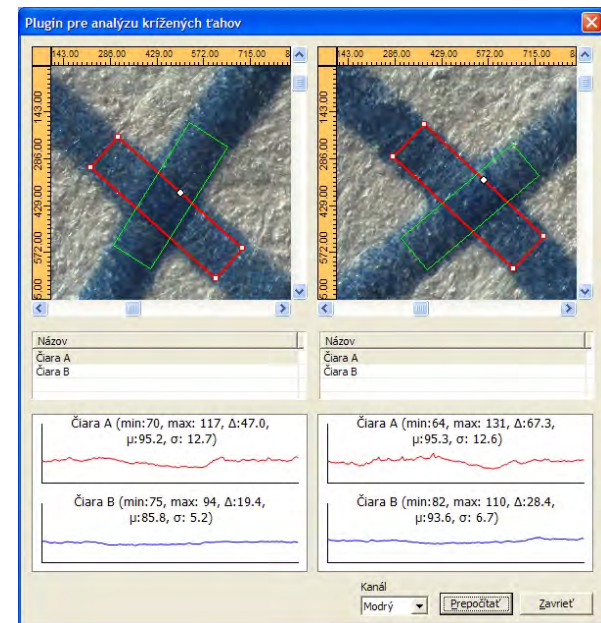
- Medzinárodný projekt (2011-2016) zameraný na skúmanie fyzikálno-chemických vlastností krížených línií, bol realizovaný pod záštitou generálneho sekretariátu Interpolu v Lyone a jeho partnera AIEED (L'Académie Internationale des Experts en Écritures et Documents).
- Kriminalistický a expertízny ústav PZ sa do projektu zapojil na základe ponuky generálneho sekretariátu Interpolu Lyon v roku 2011.

„PHYSICAL-CHEMISTRY STUDY OF CROSSED LINE INTERSECTION“

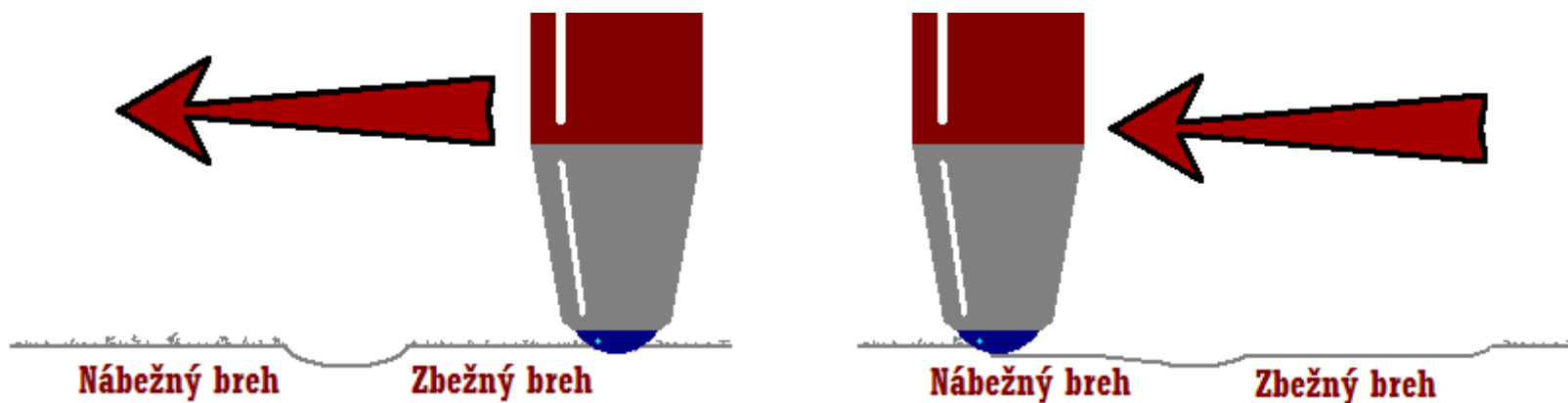
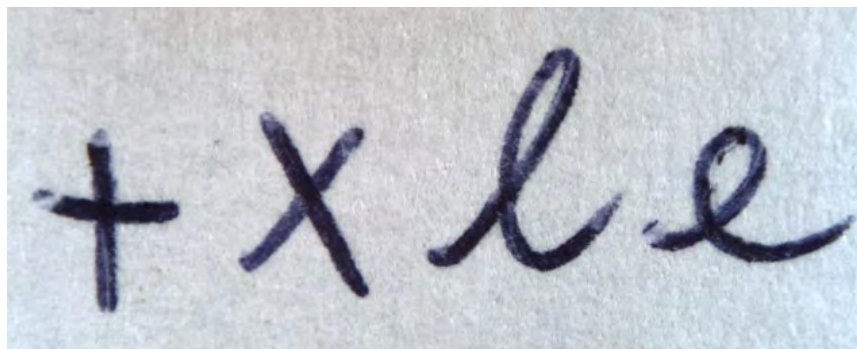
- Cieľom projektu bolo na základe výsledkov výskumu krížených ťahov prispieť do tejto náročnej forenznej problematiky.
- Komplexnou hypotézou štúdia krížených ťahov je konštatácia, že miesto kríženia dvoch križujúcich sa línií vytvorených rôznymi substanciami (atramentmi a pastami písacích prostriedkov, pečiatkovými farbami, atramentmi tlačiarňí) je miestom fyzikálnych a chemických reakcií, ktoré sú závislé od niekoľkých faktorov vrátane kvality použitých substancií, poradia použitých substancií a času ich vyhotovenia.

METÓDY

- Stereografia
- „Focus variation“
- Odlesky
- SEM



MODEL

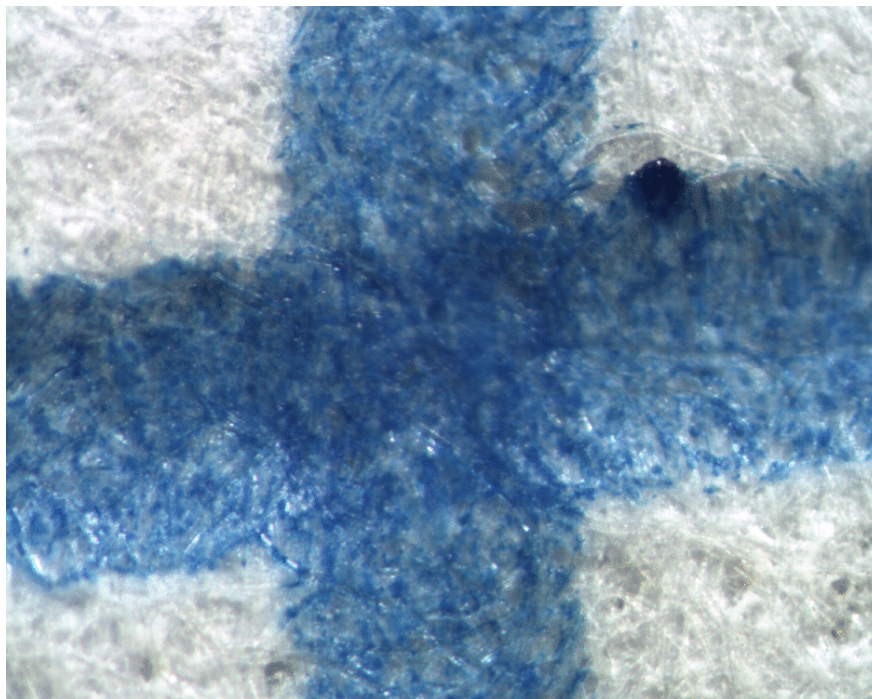
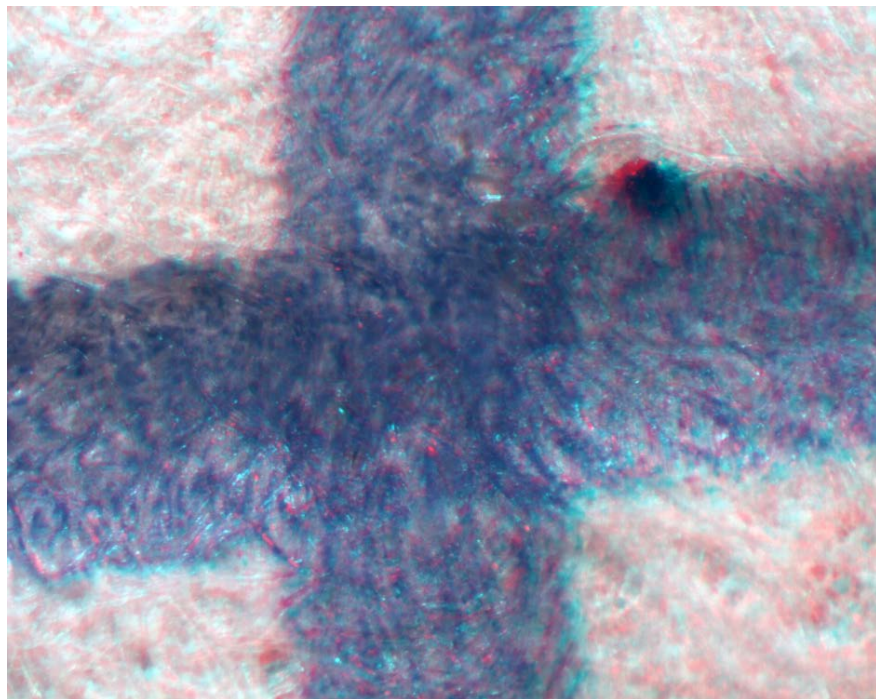


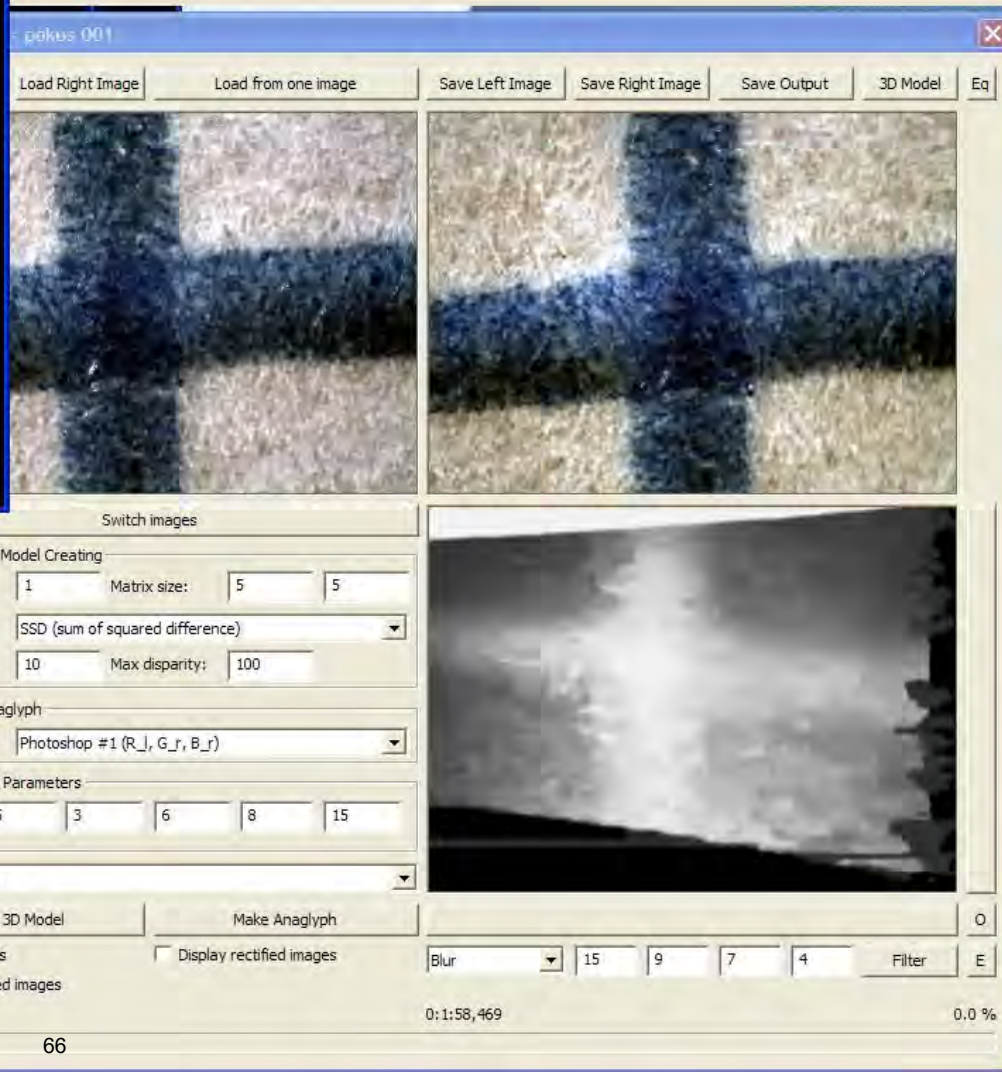
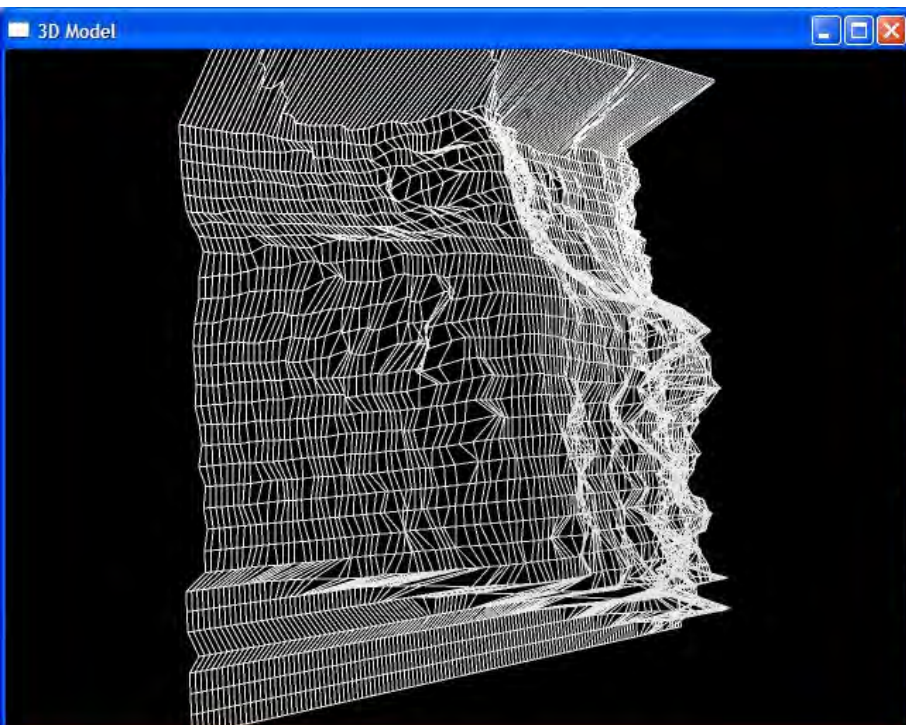
STEREOGRAFIA

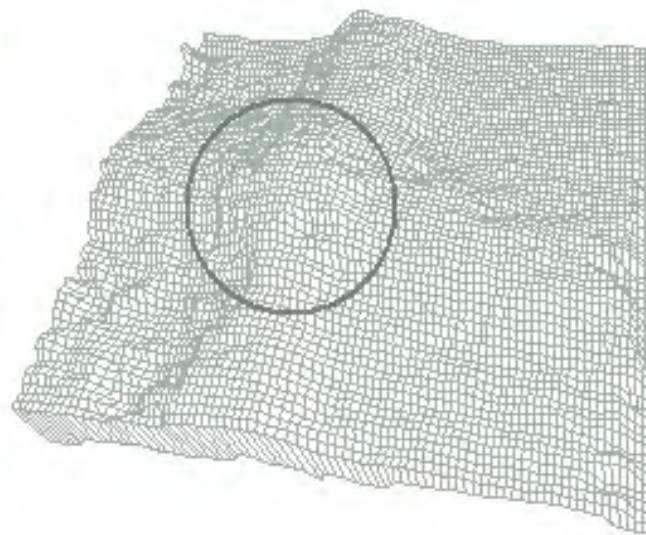
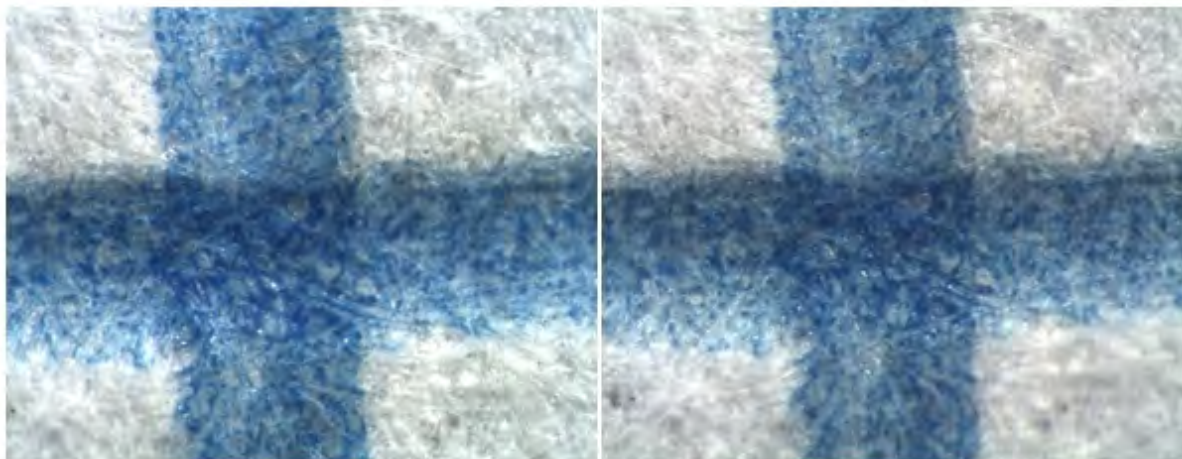
- Dve samostatné optické cesty, dve samostatné kamery
- Posunutie znakov medzi ľavým a pravým pohľadom v osi X určuje súradnicu Z



STEREO - ZÁZNAM









STEREOGRAFIA



- Farebný obraz
- Rýchla metóda
- Konzistentná s rutinne používanými metódami
- Vhodná pre papier

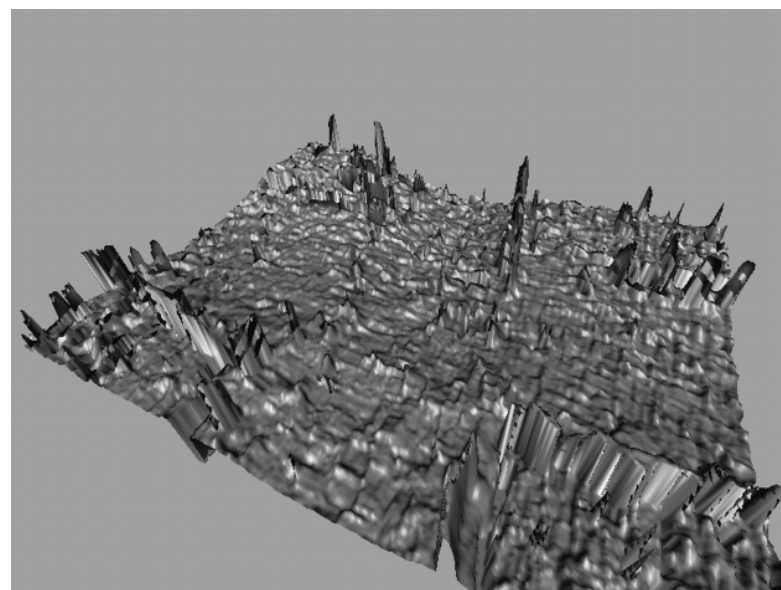
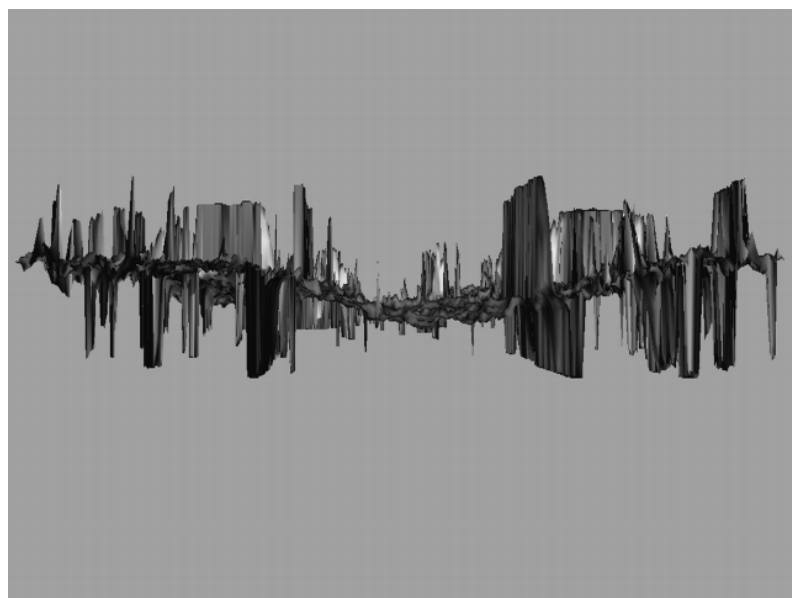
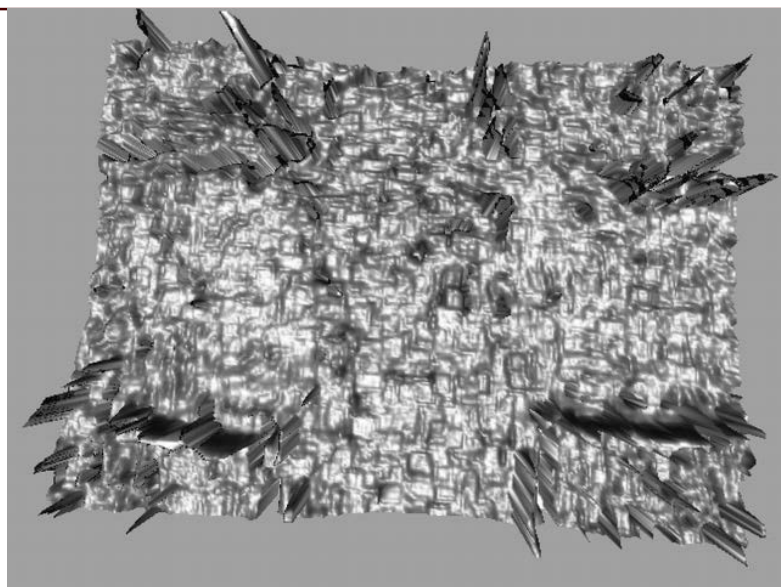


- Nutná precízna kalibrácia
- Vysoké nároky na kvalitu obrazu
- Odlesky
- Obmedzené rozlíšenie v osi Z

„FOCUS VARIATION“

- Digitálny mikroskop,
- motorizovaná os Z
- Kalibrovaný posun osi Z





FOCUS VARIATION



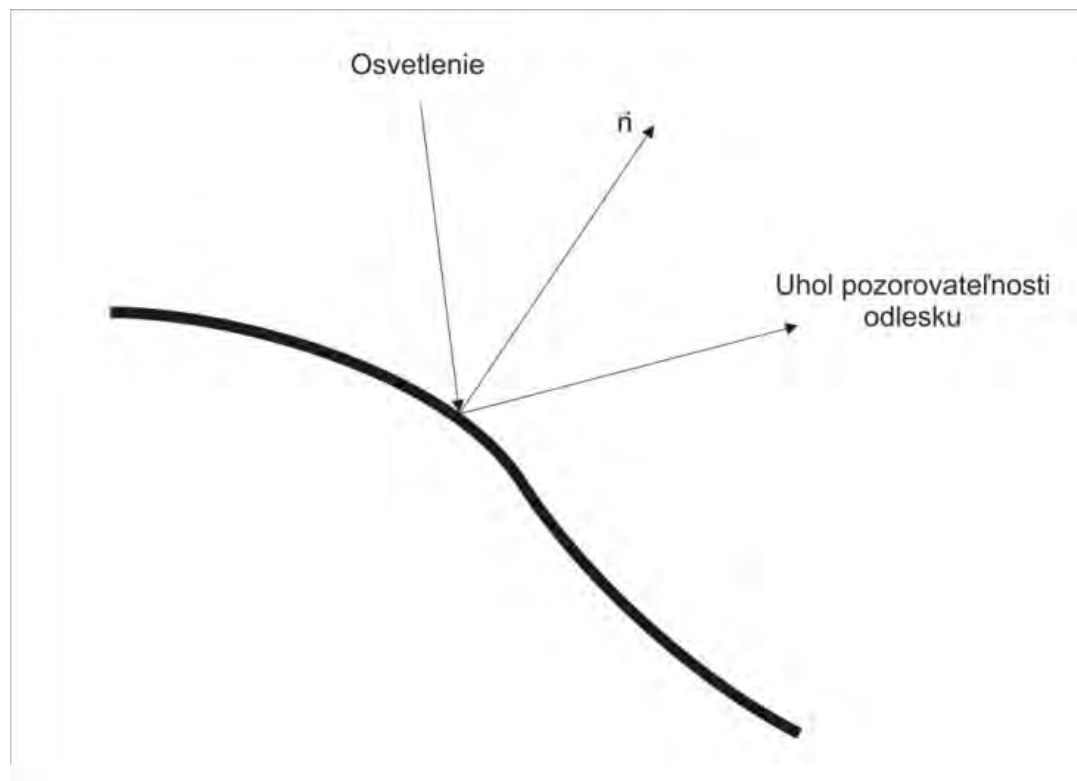
- Priame meranie hĺbky
- Dnes zahrnutá v každom motorizovanom digitálnom mikroskope

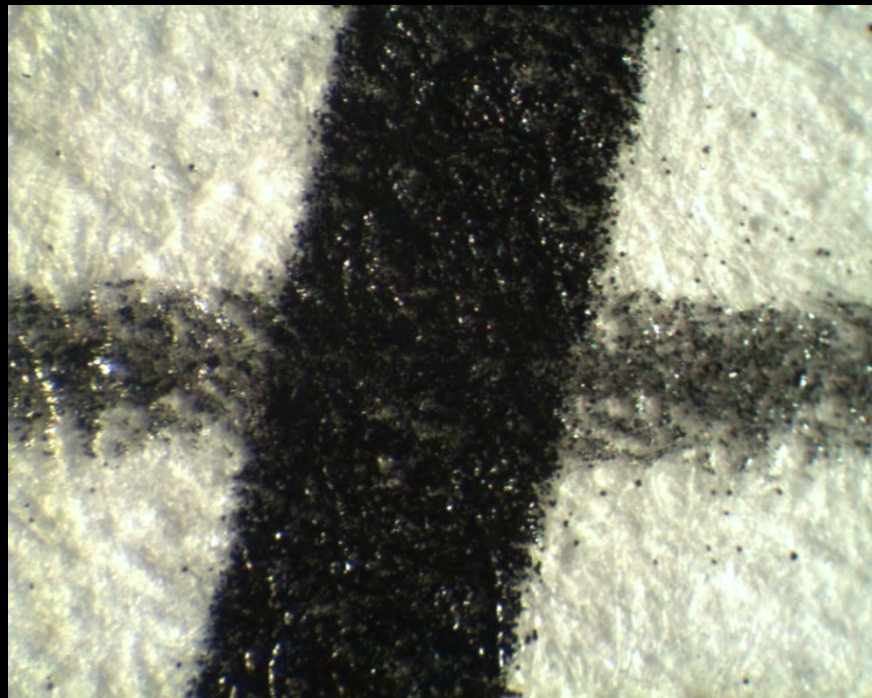
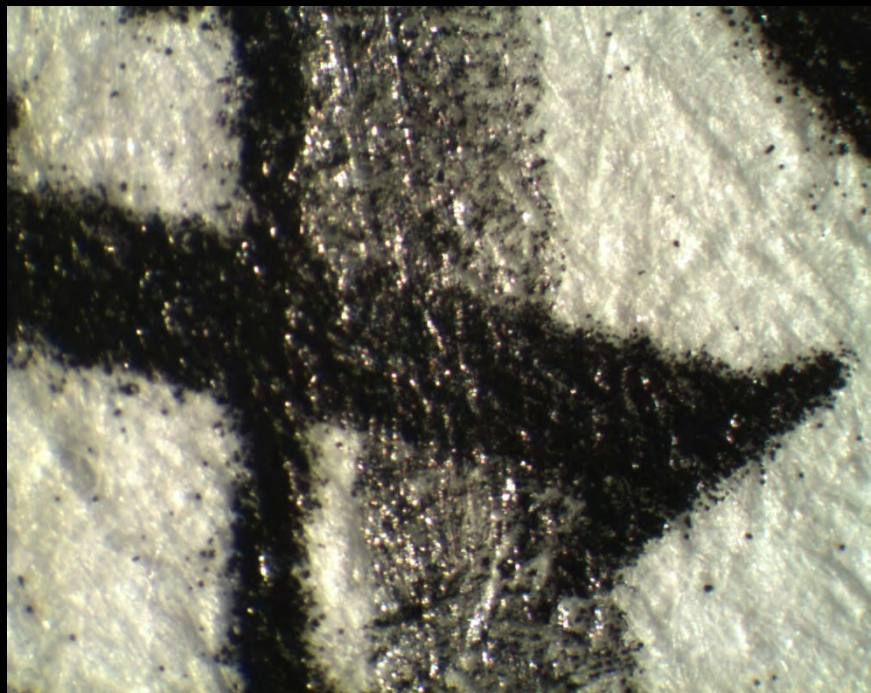


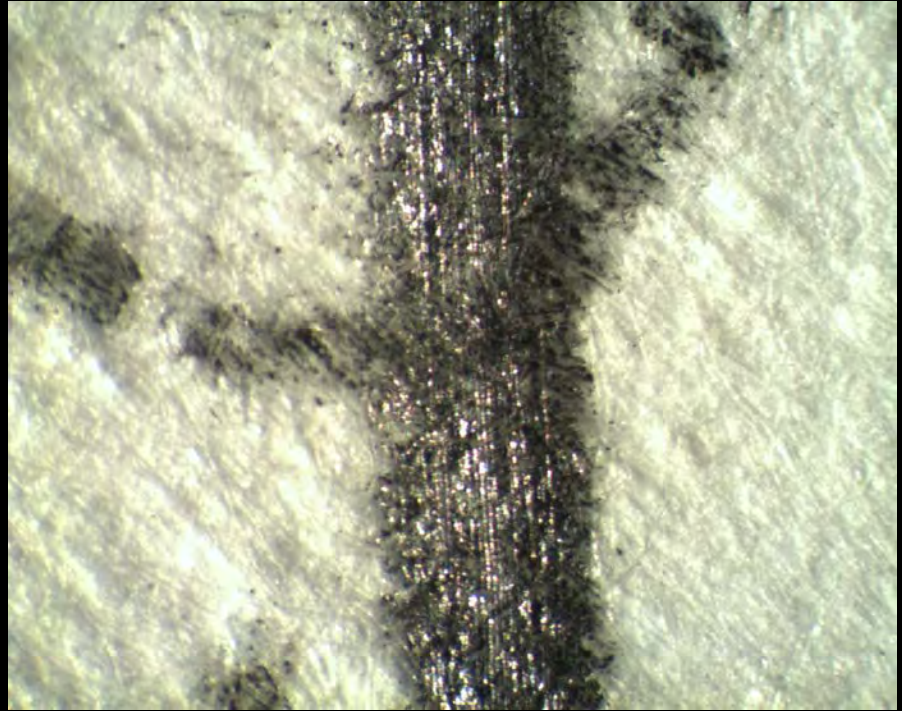
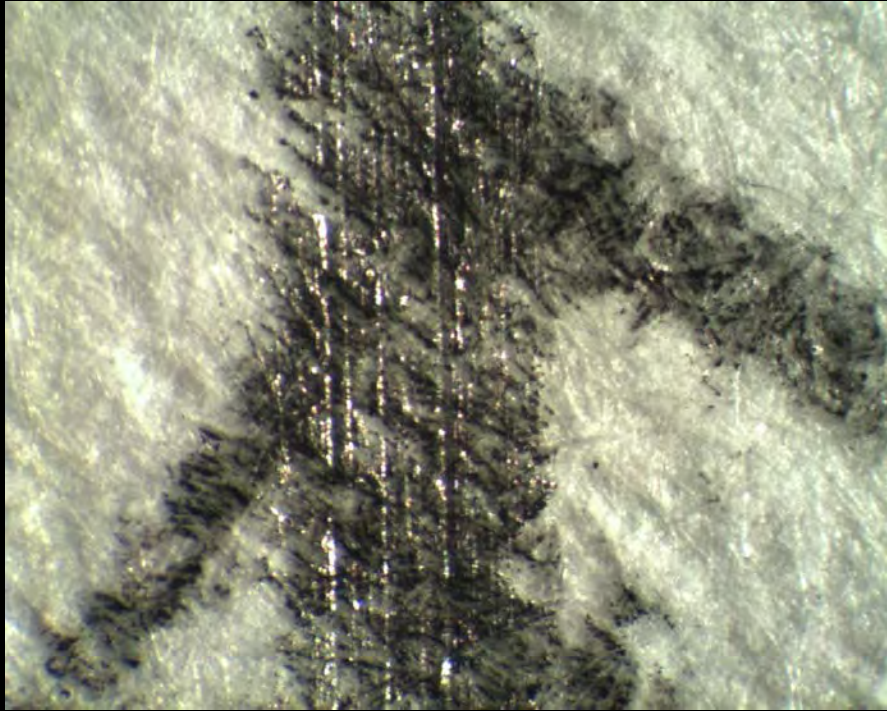
- Malé rozlíšenie v osi Z
- „Výpadky“
- Nutnosť interpolácie a filtrácie

ODLESKY

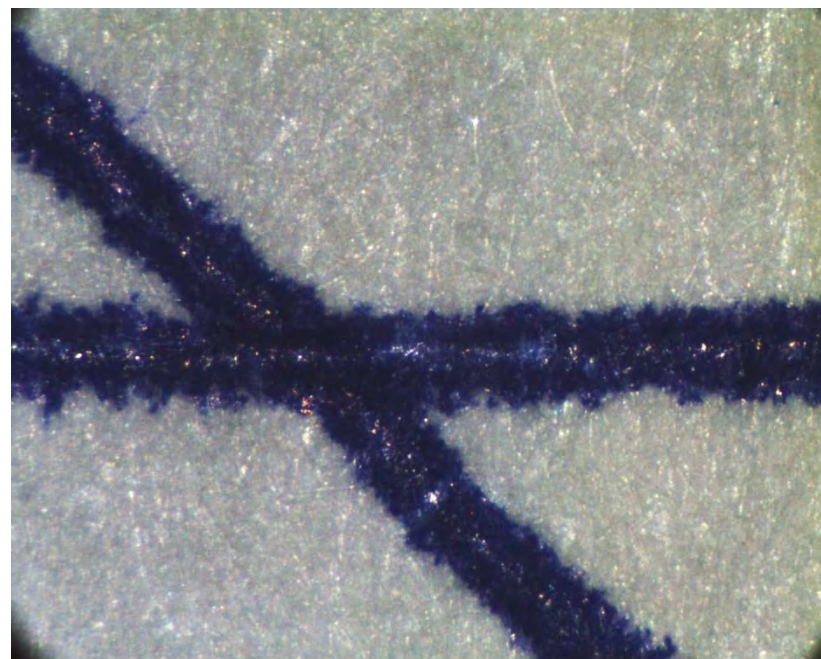
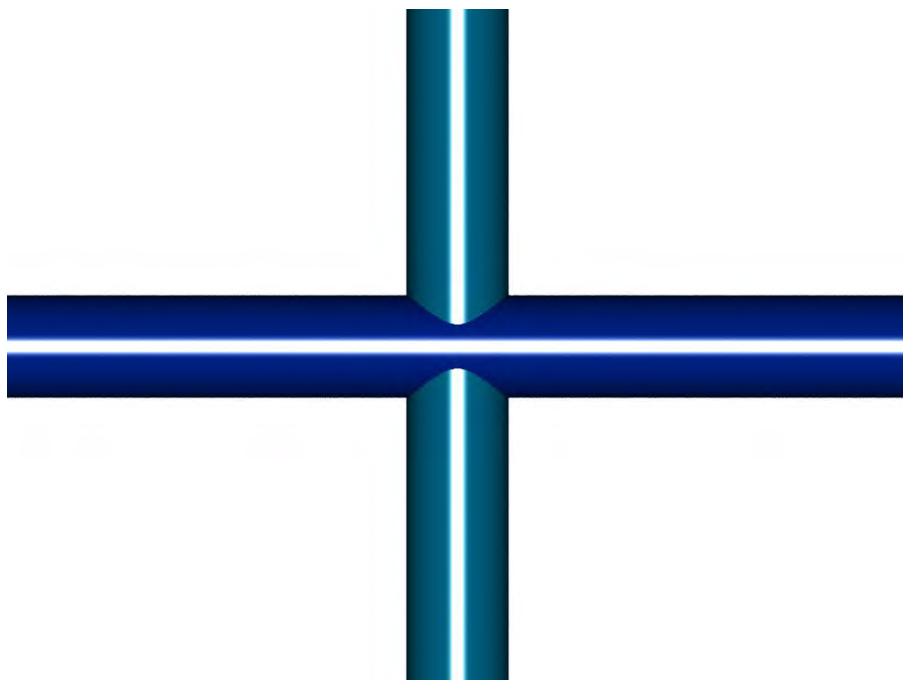
- Písacie prostriedky sa lesknú
- Štruktúra lesku nesie informáciu o normále povrchu
- Zvýrazňuje morfológiu písaného ťahu







KOAXIÁLNE SVETLO



ODLESKY



- Dostupné na každom pracovisku
- Rýchla metóda
- Intuitívne vyhodnotenie



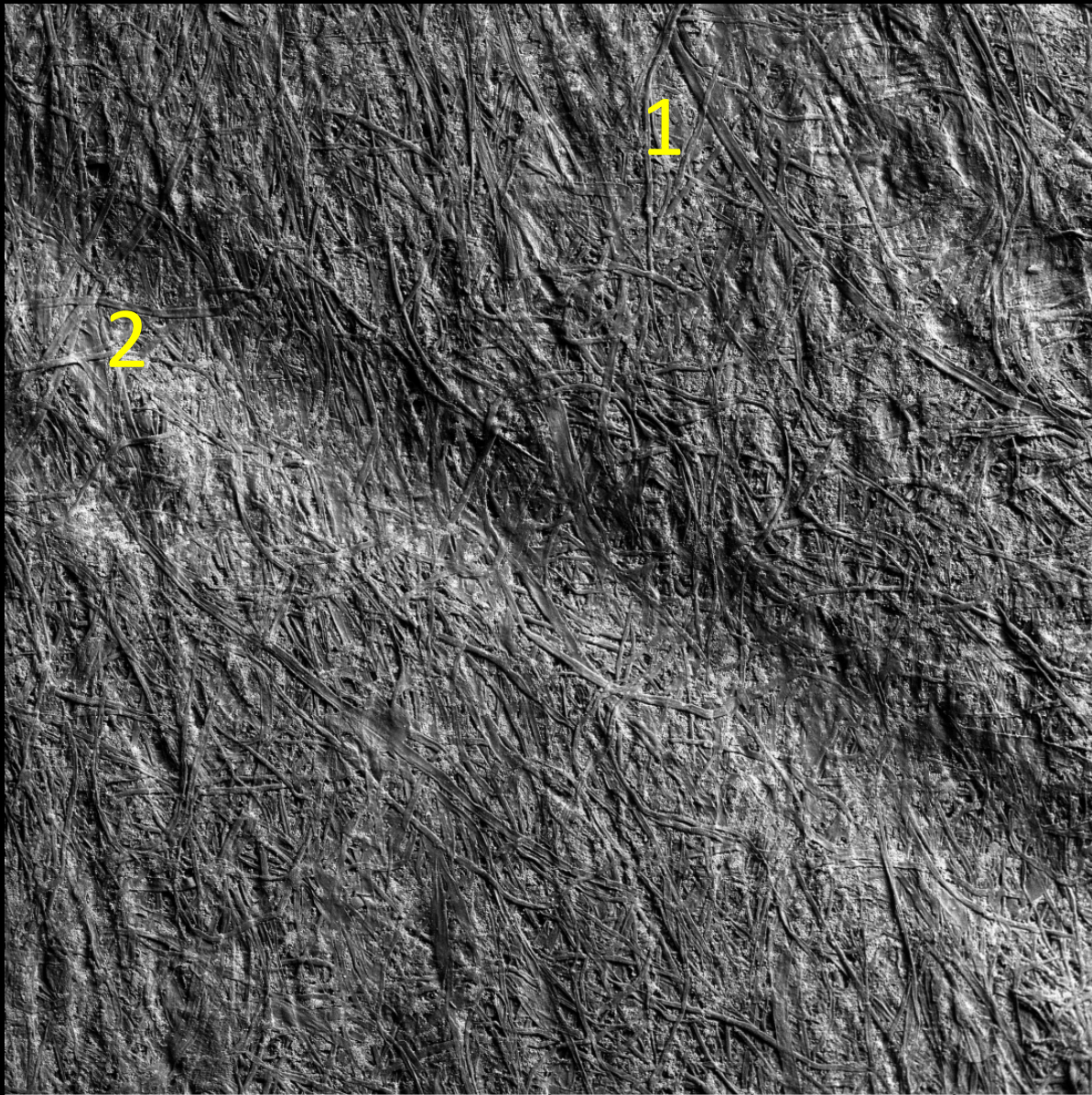
- Použiteľné iba na úzku skupinu prípadov

SEM

Elektrónová rastrovacia mikroskopia

- Sekundárne elektróny
- Odrazené elektróny
- Katódoluminiscencia





SEM MAG: 226 x

HV: 10.0 kV

VAC: LowVac, 6 Pa

DET: BSE Detector

DATE: 11/28/07

Device: TS5136MM

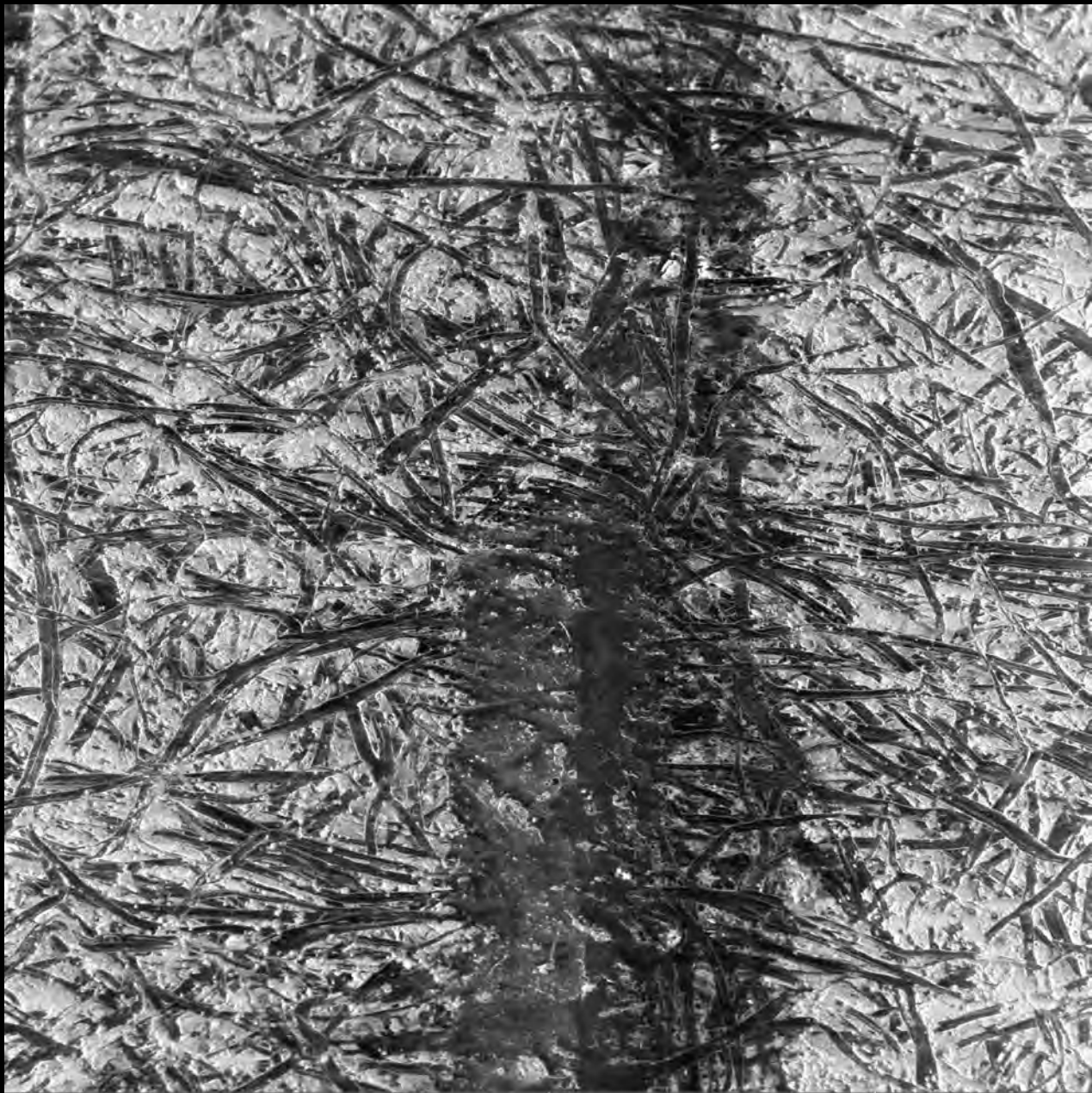


1 mm

Vega ©Tescan

Digital Microscopy Imaging

test 16 4



SEM HV: 15.0 kV

WD: 15.00 mm

WD: 15.00 mm

Det: LVSTD

VEGA3 SBU

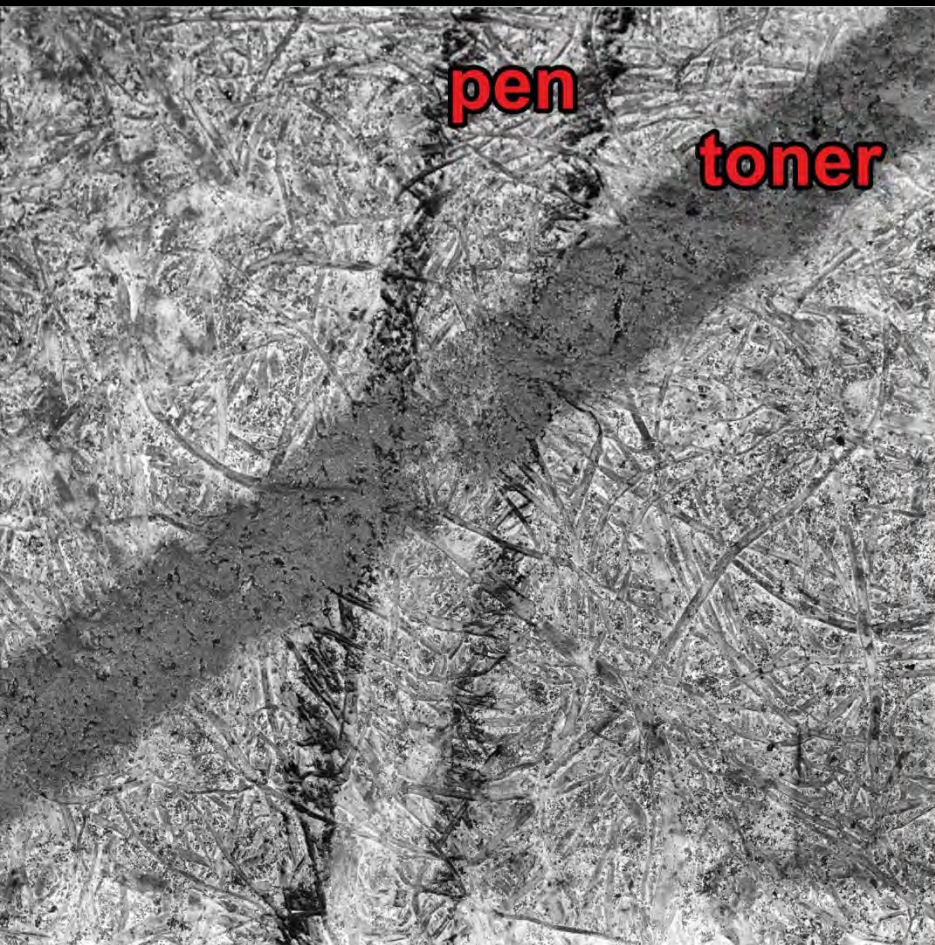
Date(m/d/y): 08/22/13

500 μ m

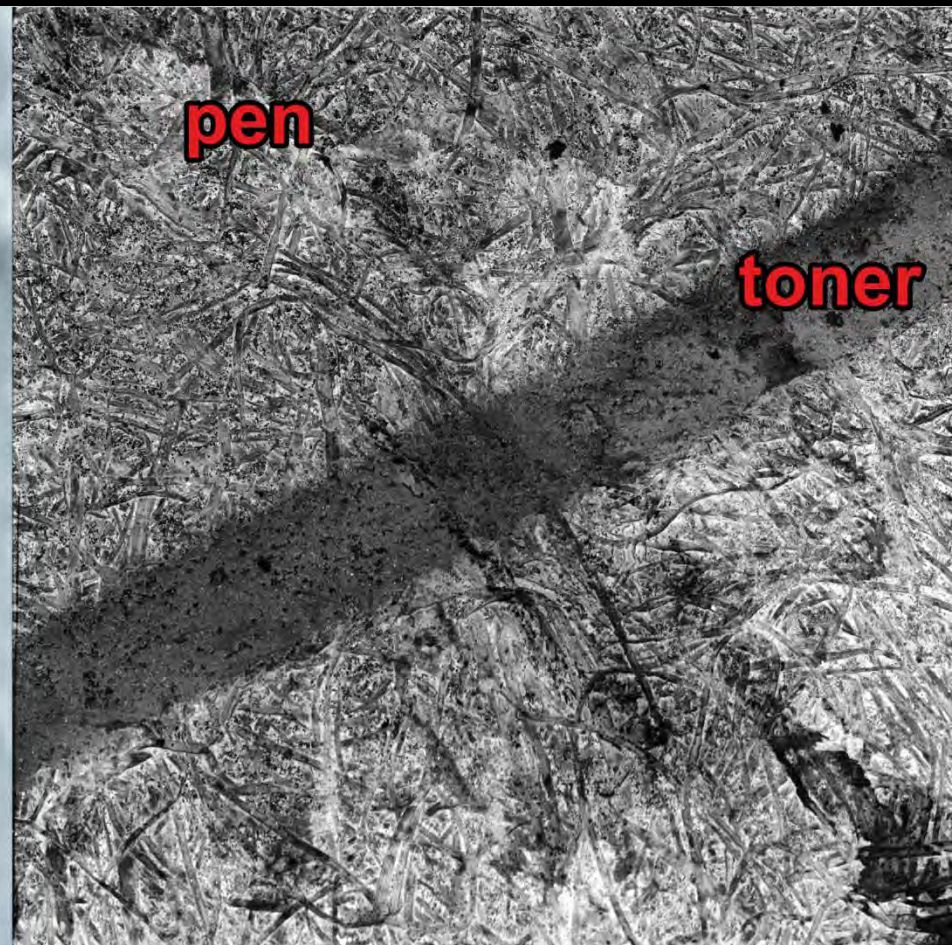
VEGA3 TESCAN

Performance in nanospace

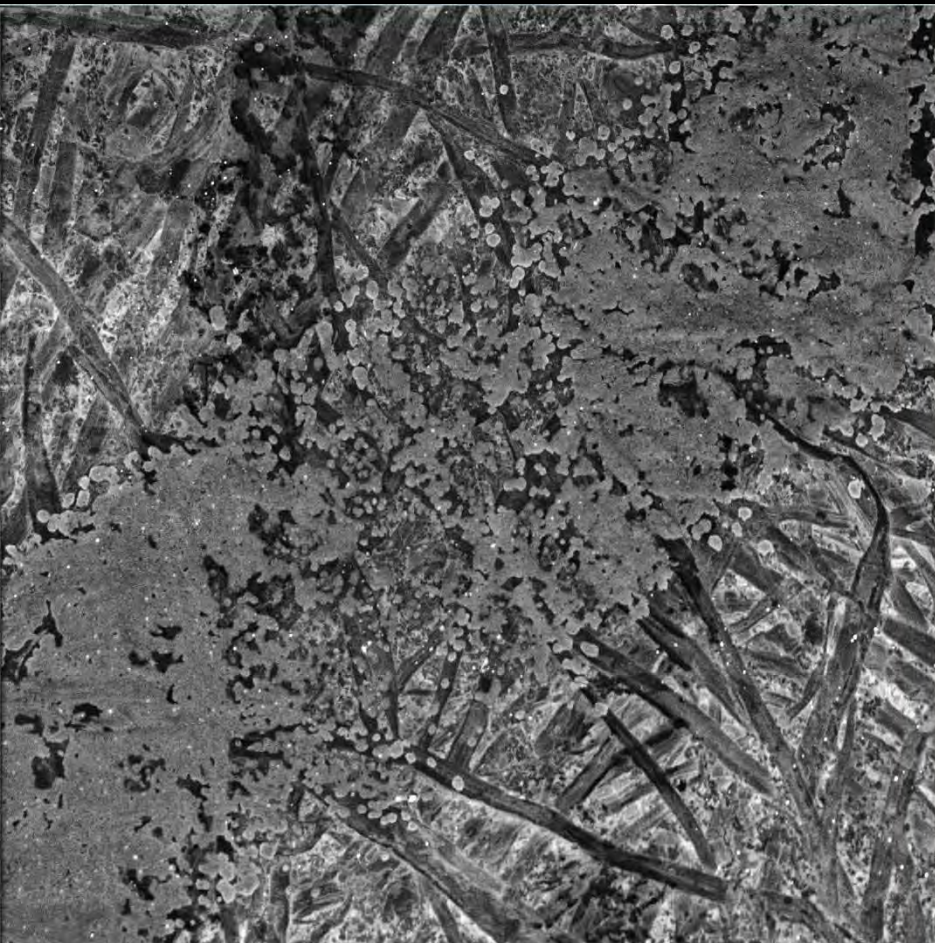




SEM HV: 5.0 kV WD: 18.84 mm VEGA3 TESCAN
View field: 2.08 mm Det: CL 500 μ m
SEM MAG: 267 x Date(m/d/y): 08/22/13 Performance in nanospace



SEM HV: 5.0 kV WD: 19.58 mm VEGA3 TESCAN
View field: 2.08 mm Det: CL 500 μ m
SEM MAG: 267 x Date(m/d/y): 08/22/13 Performance in nanospace



SEM HV: 5.0 kV

WD: 19.45 mm

VEGA3 TESCAN

View field: 708 μm

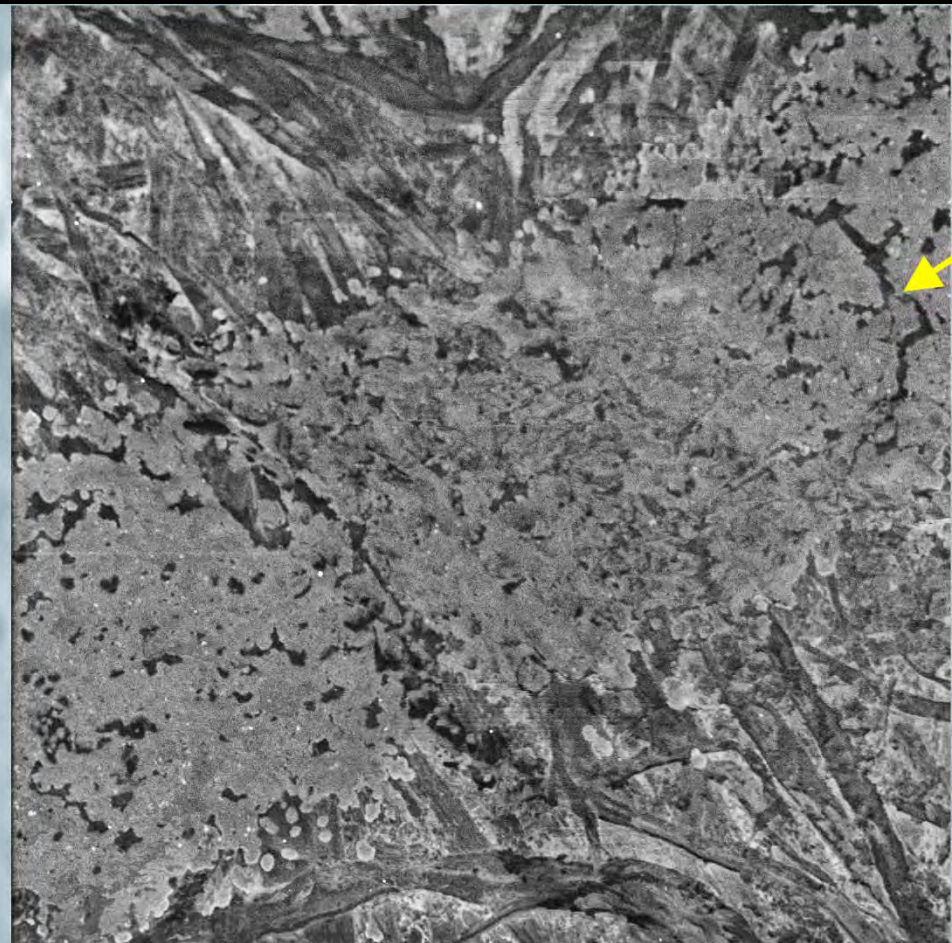
Det: CL

200 μm

SEM MAG: 782 x

Date(m/d/y): 08/22/13

Performance in nanospace



SEM HV: 5.0 kV

WD: 18.81 mm

VEGA3 TESCAN

View field: 593 μm

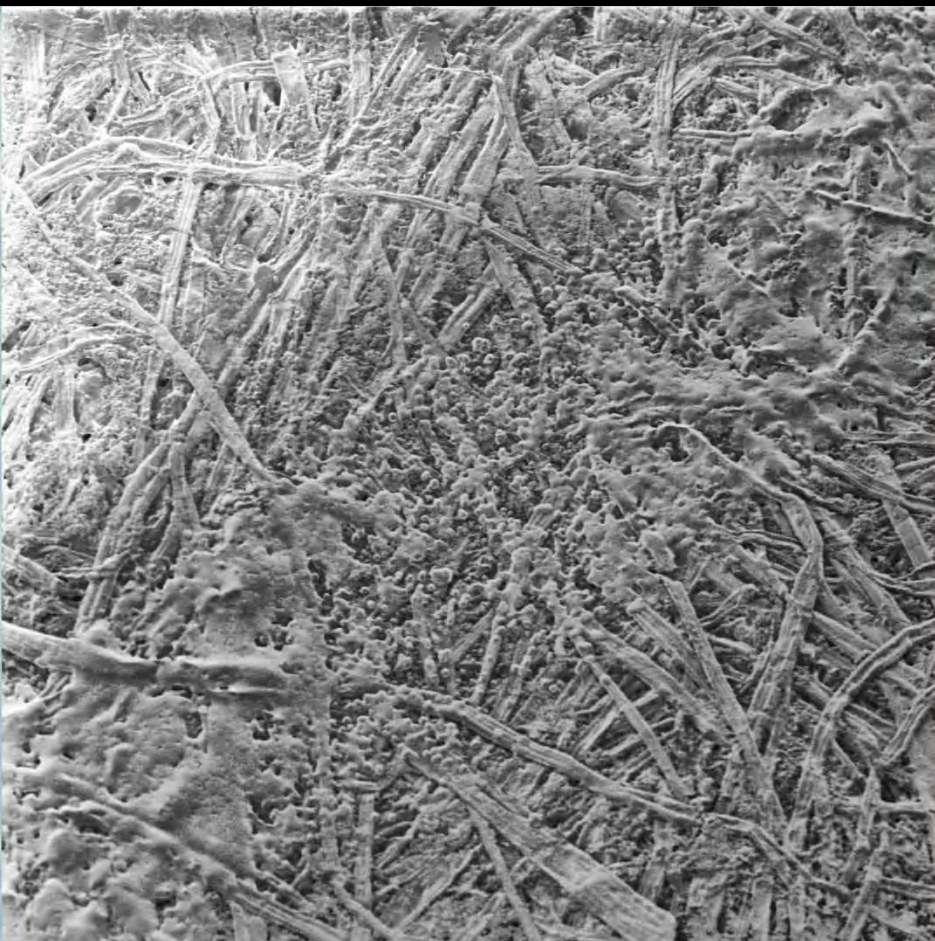
Det: CL

100 μm

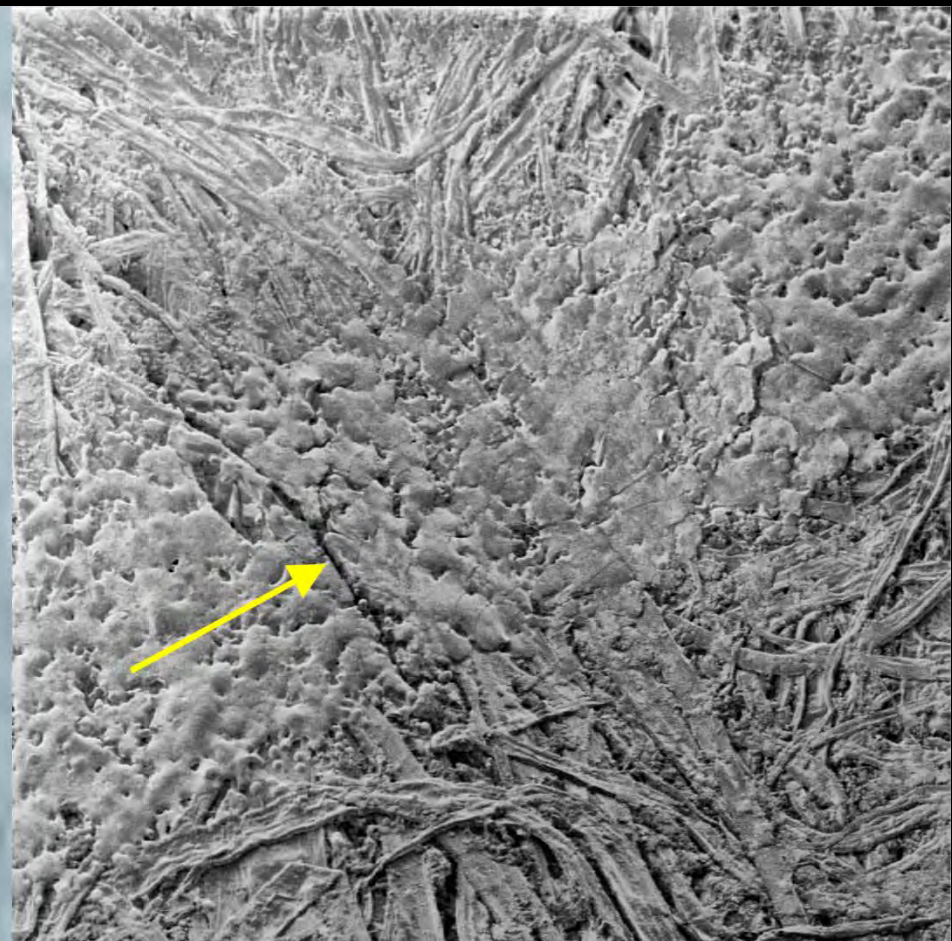
SEM MAG: 933 x

Date(m/d/y): 08/22/13

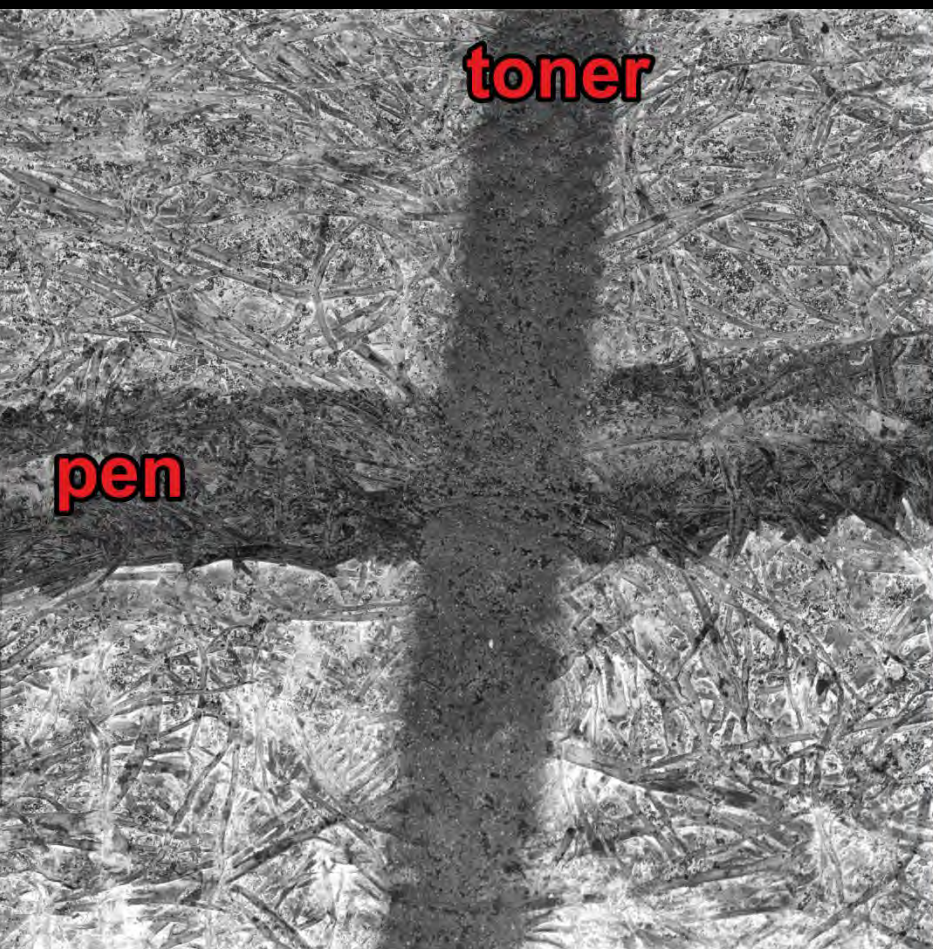
Performance in nanospace



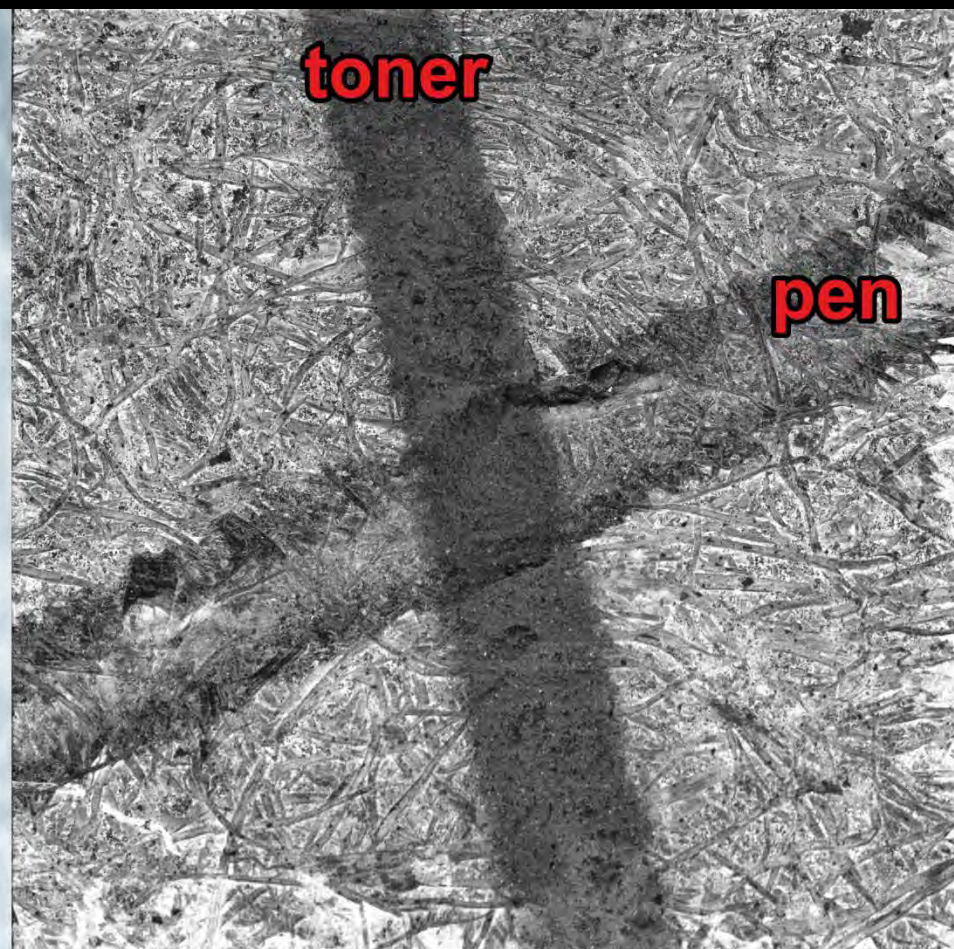
SEM HV: 1.0 kV	WD: 17.19 mm	200 μ m	VEGA3 TESCAN
View field: 1.04 mm	Det: SE		
SEM MAG: 533 x	Date(m/d/y): 08/22/13	Performance in nanospace	



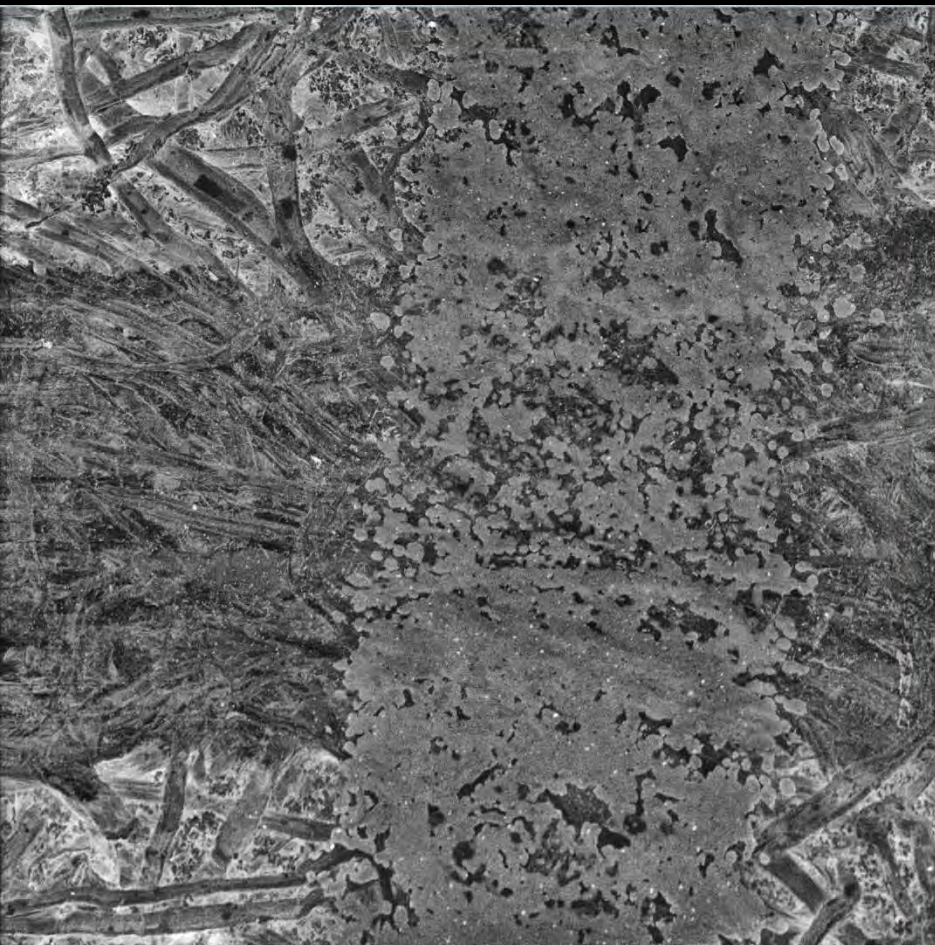
SEM HV: 1.0 kV	WD: 19.58 mm	200 μ m	VEGA3 TESCAN
View field: 830 μ m	Det: SE		
SEM MAG: 667 x	Date(m/d/y): 08/22/13	Performance in nanospace	



SEM HV: 5.0 kV	WD: 16.54 mm	VEGA3 TESCAN
View field: 2.08 mm	Det: CL	500 μ m
SEM MAG: 267 x	Date(m/d/y): 08/22/13	Performance in nanospace



SEM HV: 5.0 kV	WD: 16.54 mm	VEGA3 TESCAN
View field: 2.07 mm	Det: CL	500 μ m
SEM MAG: 268 x	Date(m/d/y): 08/22/13	Performance in nanospace



SEM HV: 5.0 kV

WD: 16.45 mm

VEGA3 TESCAN

View field: 689 μm

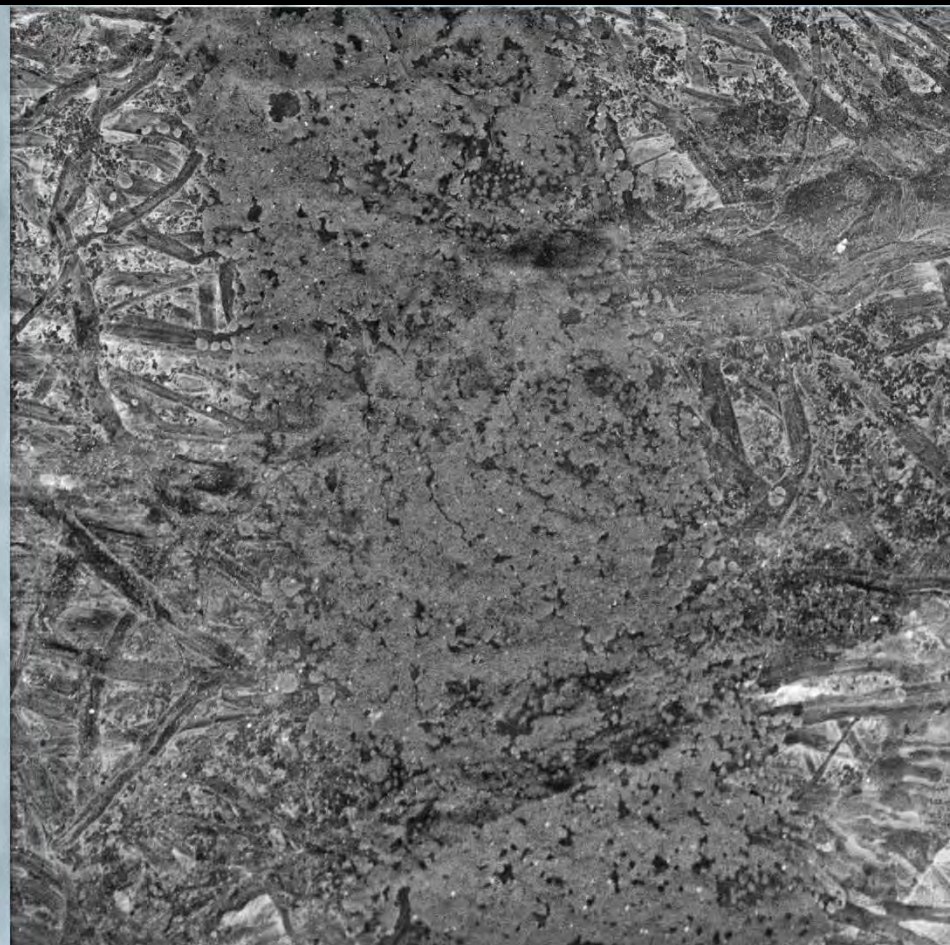
Det: CL

200 μm

SEM MAG: 803 x

Date(m/d/y): 08/22/13

Performance in nanospace



SEM HV: 5.0 kV

WD: 16.54 mm

VEGA3 TESCAN

View field: 692 μm

Det: CL

200 μm

SEM MAG: 800 x

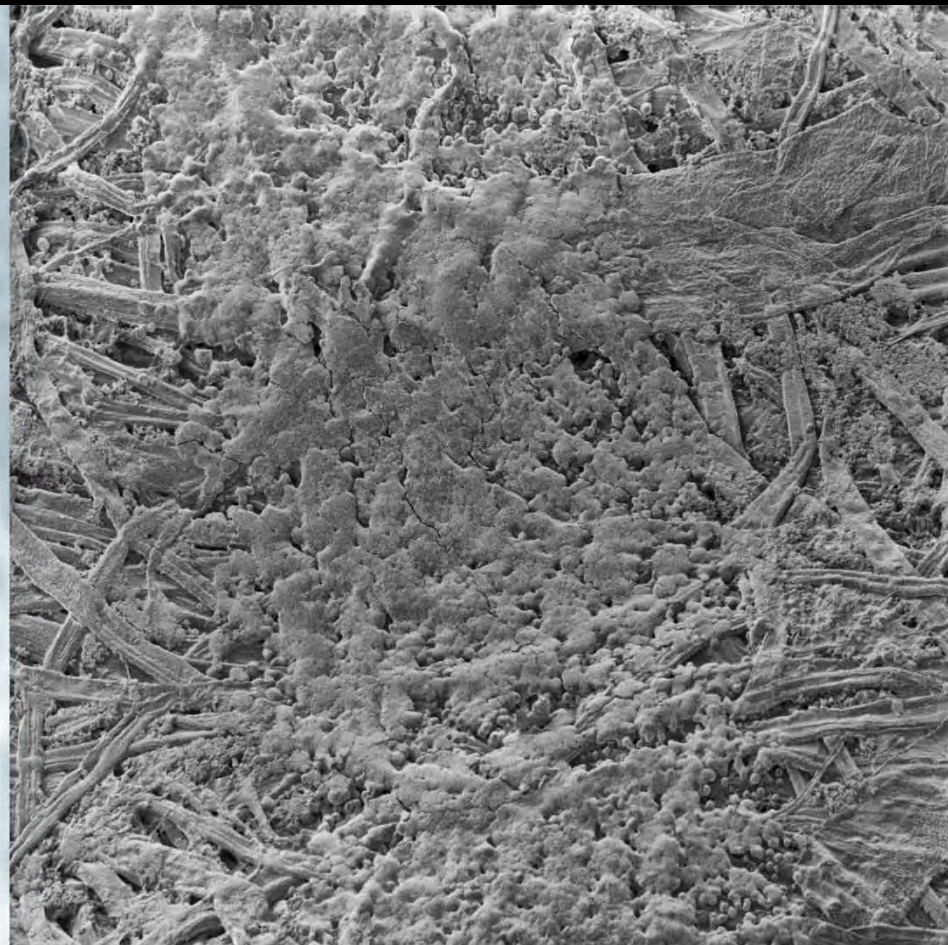
Date(m/d/y): 08/22/13

Performance in nanospace

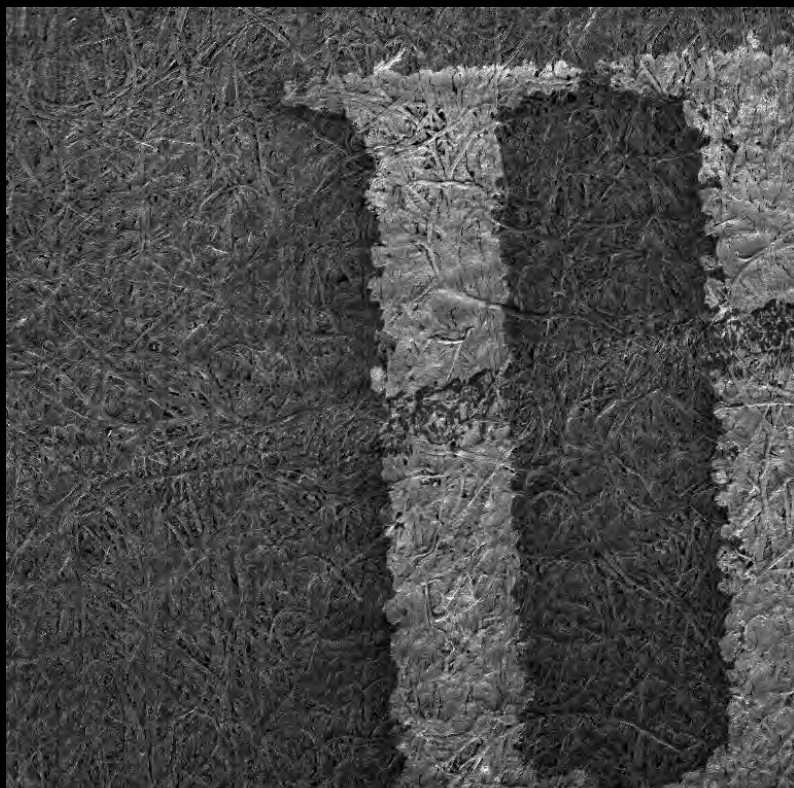




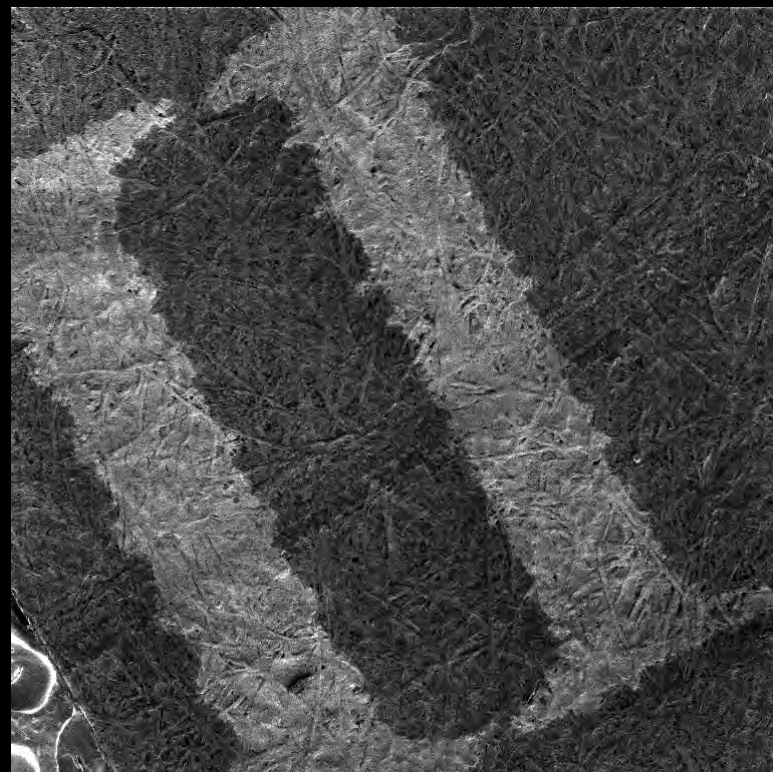
SEM HV: 1.0 kV	WD: 16.28 mm		VEGA3 TESCAN
View field: 692 μ m	Det: SE	200 μ m	
SEM MAG: 800 x	Date(m/d/y): 08/22/13	Performance in nanospace	



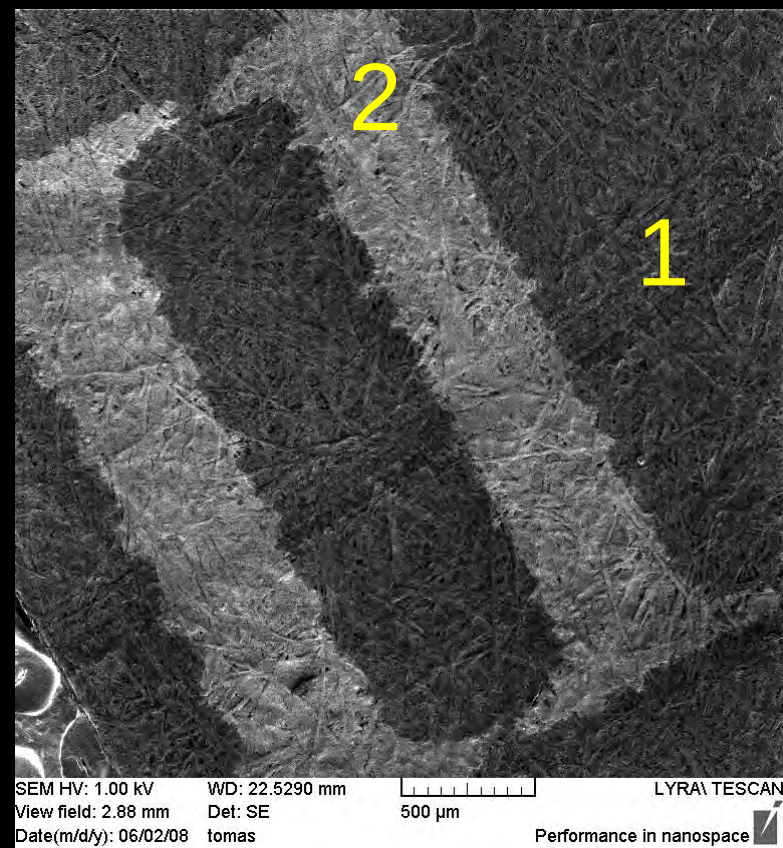
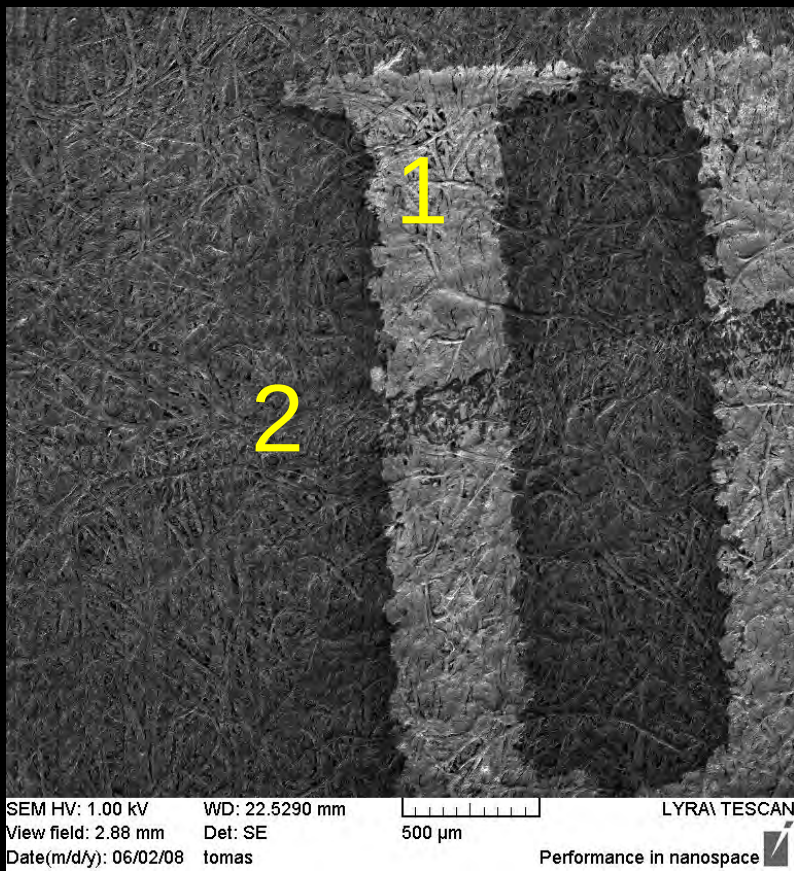
SEM HV: 1.0 kV	WD: 16.66 mm		VEGA3 TESCAN
View field: 692 μ m	Det: SE	200 μ m	
SEM MAG: 800 x	Date(m/d/y): 08/22/13	Performance in nanospace	



SEM HV: 1.00 kV WD: 22.5290 mm LYRA\TESCAN
View field: 2.88 mm Det: SE
Date(m/d/y): 06/02/08 tomas
500 μ m
Performance in nanospace



SEM HV: 1.00 kV WD: 22.5290 mm LYRA\TESCAN
View field: 2.88 mm Det: SE
Date(m/d/y): 06/02/08 tomas
500 μ m
Performance in nanospace



SEM



- Vysoká hĺbka ostrosti
- Možnosť zobrazit' iba morfológiu papiera bez písacích prostriedkov
- Intuitívne vyhodnotenie
- Chemická analýza



- Vákuum
- Nutnosť skladať dokument
- Závislé od chemického zloženia písacích prostriedkov
- Cena

ZÁVER

- Výskumná úloha nám ako výsledok nedáva jednu univerzálnu metódu, ktorá by všeobecne riešila krížené ťahy.
- Výsledkom je súbor metód, pri ktorých sme preskúmali ich aplikovateľnosť.
- Nasadením každej metódy sa nám otvára nový pohľad na problém a zviditeľňujú sa nám nové charakteristické znaky jednotlivých ťahov.
- Výsledkom výskumnej úlohy je kategorizácia vzoriek a následné priradenie najvhodnejšej metódy pre daný typ úlohy

3D MEASUREMENT OF SURFACE STRUCTURES IN DEFECTOSCOPY

RNDr. Milan Držík, PhD. ¹

¹ International Laser Centre, Bratislava

3rd INTERNATIONAL CONFERENCE

3D MEASUREMENT AND IMAGING

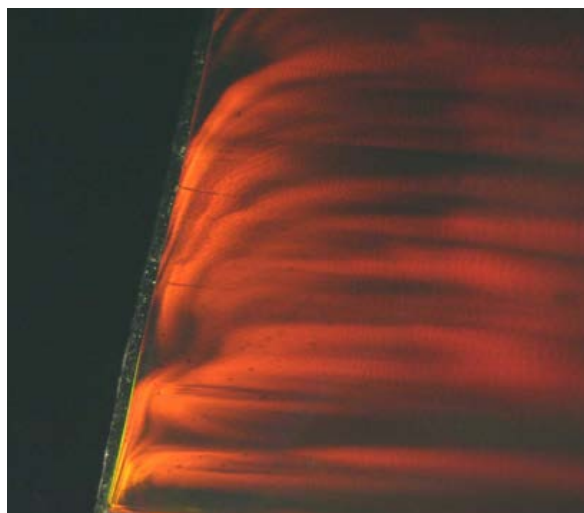
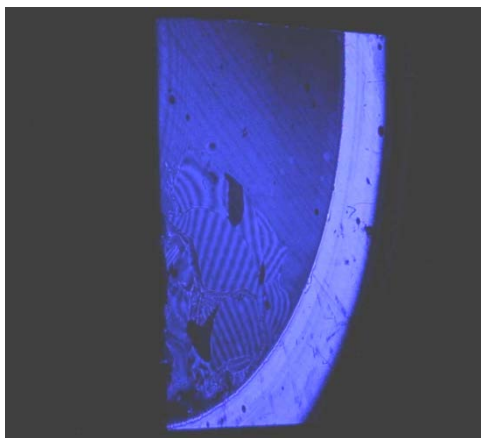
*MODERN CONTACTLESS MEASUREMENTS
IN INDUSTRIAL PRACTICE*

**3D SURFACE STRUCTURES MEASUREMENT IN
DEFECTOSCOPY**

Optical contactless methods

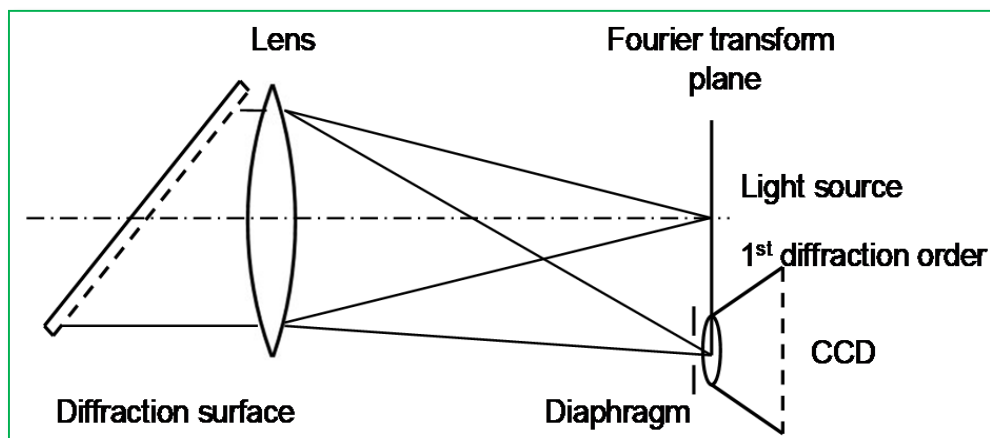
Využitie optickej filtrácie a tmavého poľa na určenie tvaru defektov tenkých vrstiev

- Nasnímaním povrchového mikropofilu pomocou AFM prípadne SEM možno zistiť jeho základné geometrické rozmery a vlastnosti, okrem laterálnych rozmerov aj hĺbkový profil. Tento prístup je však realizovateľný len na malých vybraných oblastiach povrchu s plochou niekoľkých štvorcových mikrometrov. Aby bolo možné diagnostifikovať profil štruktúry, jeho homogenitu a tiež identifikovať defekty nanoštruktúr na oveľa väčších plochách, navrhli sme a realizovali optické metódy založené na využití šikmého bočného osvetlenia ako aj difrakcie svetla na periodických povrchových štruktúrach.
- Princíp merania spočíva v osvetlení povrchu diagnostifikovanej štruktúry pod vhodným uhlom a pozorovaní rozptýleného svetla alebo svetla difragovaného na periodickej nanoštruktúre. Pozorovanie celého zorného poľa je zabezpečené v optickej schéme s využitím tzv. high-pass fourierovskej optickej filtrácie.



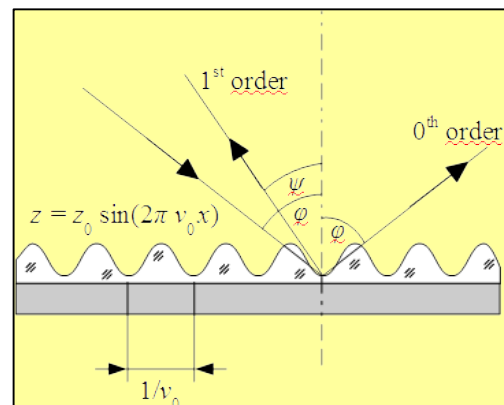
3D tvary defektov periodickej štruktúry

- Základné výhody, ktoré diagnostický postup poskytuje spočívajú predovšetkým v tom, že možno pozorovať a naraz zosnímať veľké plochy t.j. 6, 8 i viac-palcové substráty. Na celej ploche sa pritom výrazne vizualizujú defekty povrchu s periodickou nanoštruktúrou. Metóda je nenáročná na prístrojové vybavenie a realizovateľná aj s použitím zdroja bieleho svetla.
- Keďže difrakčná účinnosť periodickej štruktúry je priamo úmerná hĺbke modulácie, jej vyhodnotením pomocou optickej schémy na obrázku, je umožnená aj kvantifikácia hĺbky povrchového profilu t.j. hĺbky modulácie štruktúry.
- Skúsenosti ukázali, že ľudské oko pri vhodnom osvetlení môže sledovať aj väčšie oblasti, pri zisťovaní oblastí defektov a bodových defektov $> 100 \mu\text{m}$.

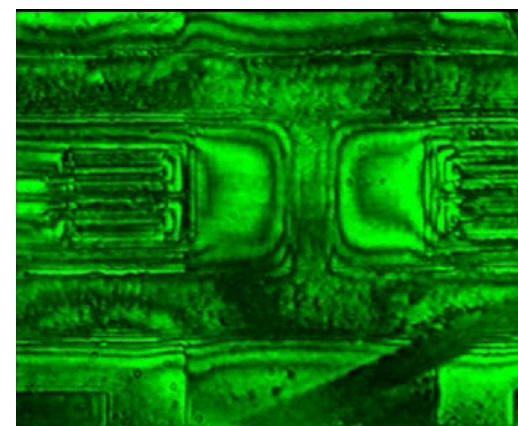
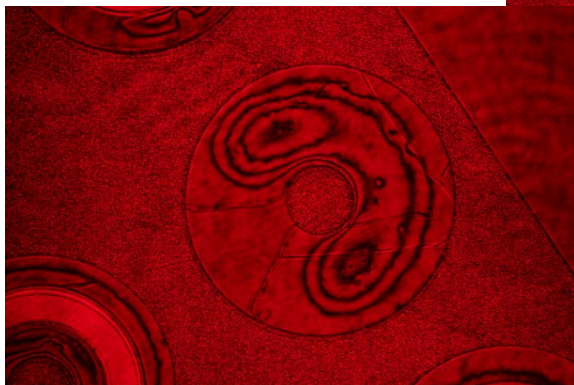
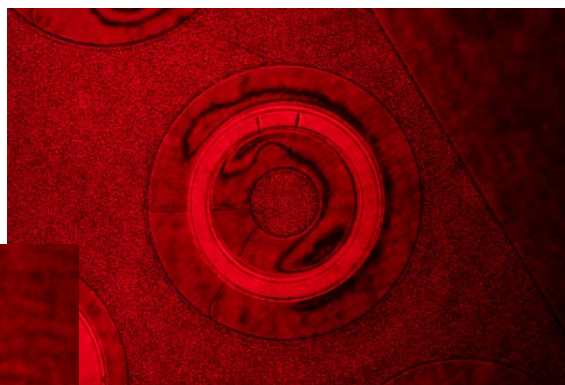
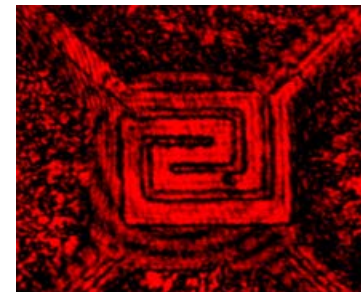
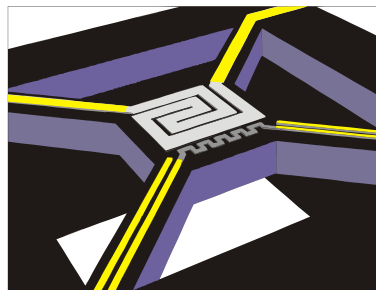
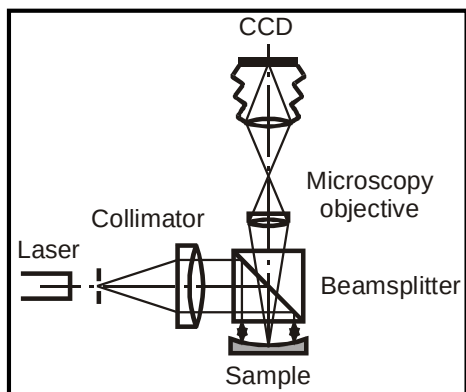


Kvantifikovanie parametrov periodického 3D povrchového profilu

- Diagnostika mriežkových periodických štruktúr optickými prostriedkami. Štruktúry sú vytvorené ako transparentné vrstvy submikrónovej hrúbky s periodickou moduláciou povrchového profilu. Ich primárnym účelom je využitím vlastností skrížených mriežok zabezpečiť antireflexné vlastnosti vrstiev. Keďže profil má sledovať harmonický priebeh, dôležité je aj diagnostifikovanie jeho geometrie.
- Rozpracovali sme metódu, ktorá umožňuje s využitím merania difrakčnej efektivity určiť hĺbku modulácie a prípadne deformáciu „harmonického priebehu“ povrchového profilu. Na základe skalárnej teórie difrakcie svetla na fázových mriežkach sme odvodili vzťahy pre interpretáciu nameraných veličín difrakčnej efektivity v jednotlivých difrakčných rádoch. Súčasne bola realizovaná schéma fotoelektrického snímania difrakčných uhlov a účinnosti fázových štruktúr vytvorených na povrchu zrkadlovo odrážajúcich substrátov. Experimentálne testovanie potvrdilo aplikovateľnosť takéhoto prístupu aj na štruktúry s periódou blízkou $\lambda/2$.
- Použitím svetla Nd:YAG lasera v oblasti kratších vlnových dĺžok ($\lambda=473$ nm) sme zabezpečili diagnostiku mriežok s periódou $p=259$ nm.

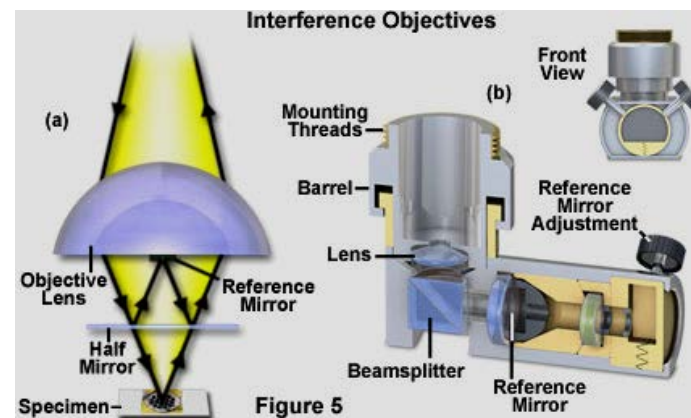
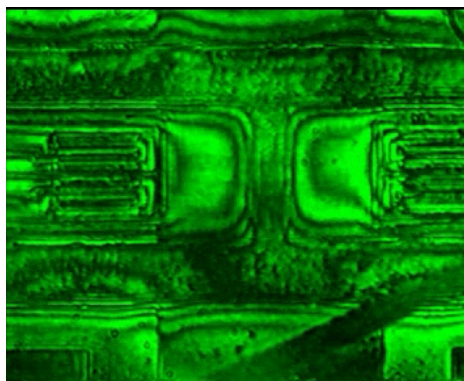
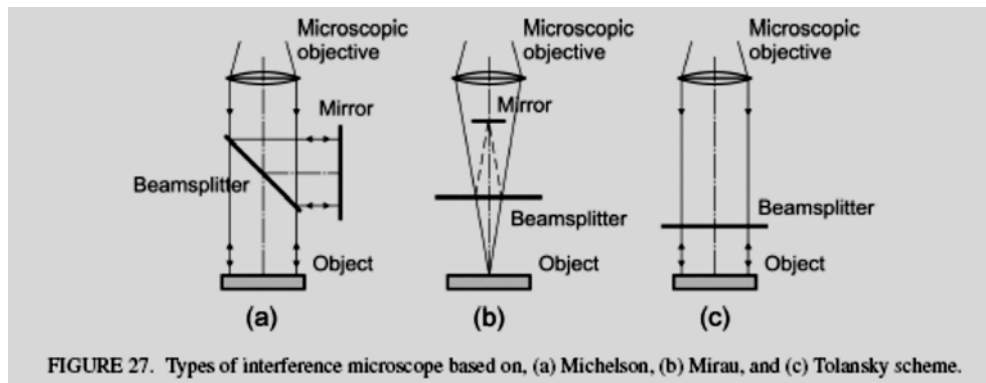
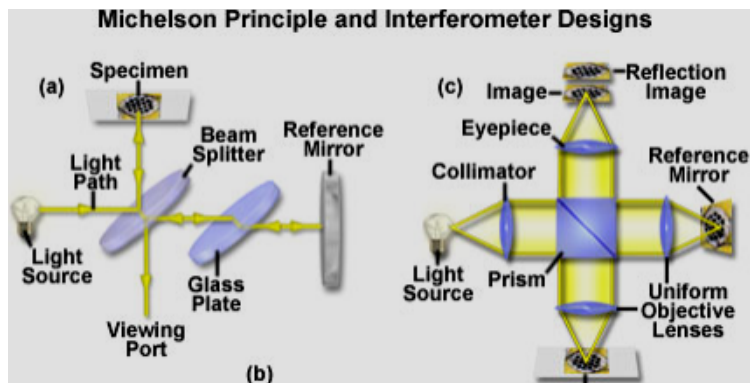


Interferenčné sledovanie defektov a profilu membrán



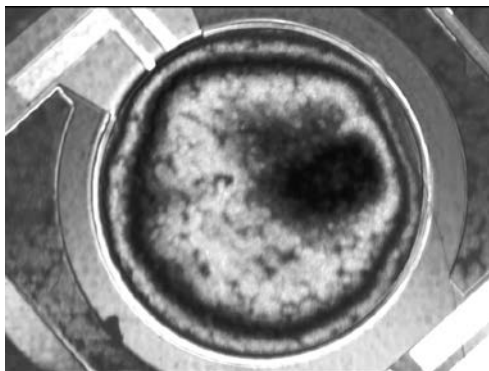
Interferenčný mikroskop

Metóda dvojlúčovej interferencie

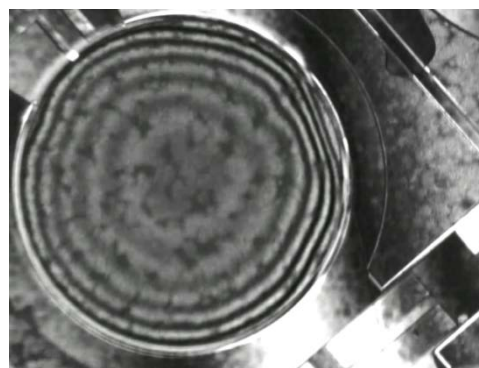
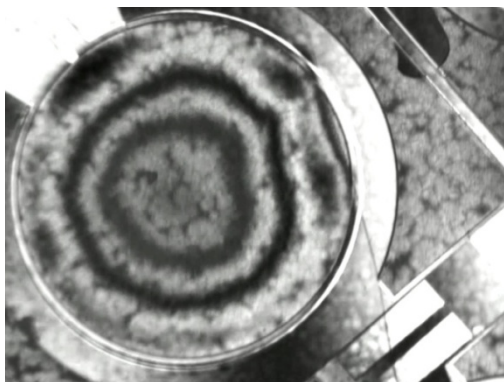
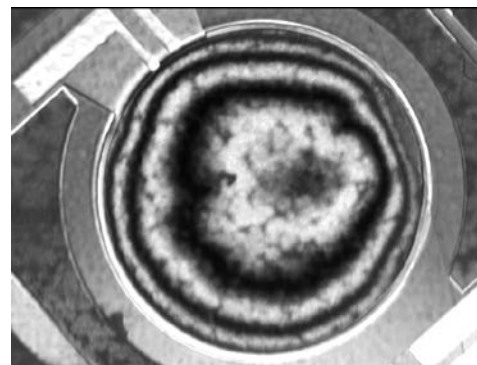


Meranie defektov tvaru membránových štruktúr

White light interferometry Bruker Contour GT-K1

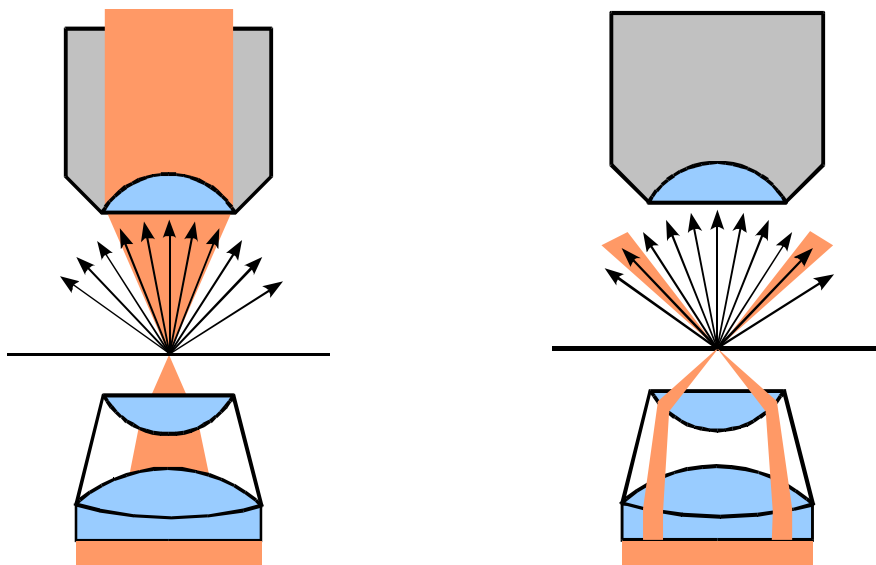


$$\sigma_0 + \sigma_P = \frac{PR}{2t}$$



Pozorovanie v tmavom/svetlom poli

Zlepšenie kontrastu obrazu – tmavé pole/svetlé pole



Základným princípom **metódy svetlého poľa** je podmienka sústrediť všetko nerozptýlené (nedifragované) svetlo do objektívu

Pozorovanie v tmavom poli

zobrazovanie objektu iba svetlom rozptýleným na jeho hranách, drobných detailoch a nehomogenitách – pozadie obrazu je tmavé

Optický princíp - vylúčenie svetla z kondenzora, ktoré by nerozptýlené vchádzalo do objektívu

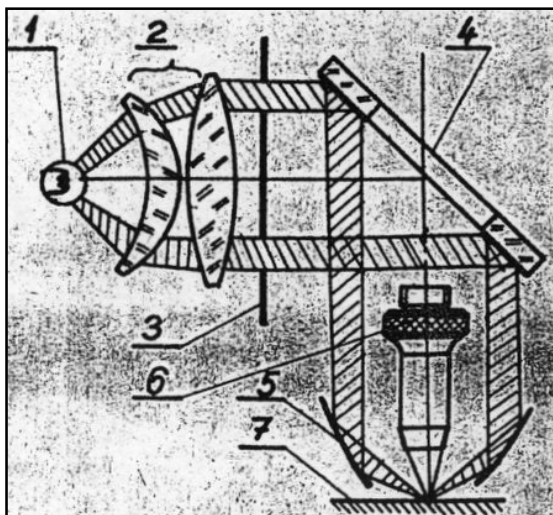
Najjednoduchšie - pri šikmom osvetlení tak, aby zrkadlovo odrazená, alebo priamo prechádzajúca časť svetla nezasiahla objektív

Identifikácia 3D tvaru defektov metódou tmavého poľa

- **Reflected Light Microscopes**

Priemyselné reflexné mikroskopy so širokým zorným poľom a konfokálne mikroskopy sú nástroje monitorovania procesov a kontroly kvality v oblasti polovodičových technológií. Defektoskopia integrovaných obvodov, nehomogenita vrstiev, a chyby technologických procesov pri depozícii vrstiev na substrátoch si vyžadujú sofistikované svetelné mikroskopické prístroje. Vyspelý optický systém by mal poskytovať optimálne osvetlenie, veľkú hĺbku ostrosti, vysokokorigované objektívy, dobrý kontrast obrazu.

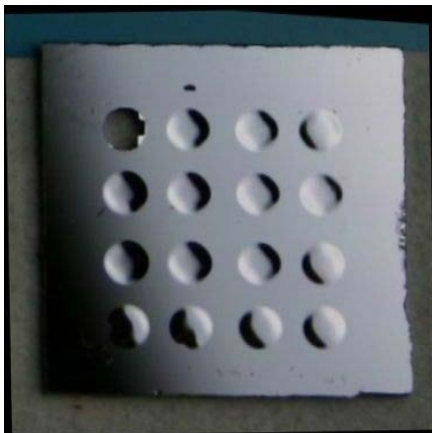
- Jedným z dôležitých prístupov je využitie osvetlenia diagnostifikovaného objektu metódou tmavého poľa.



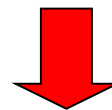
Epi-iluminátor osvetlenie zrkadlovo odrážajúceho povrchu zboku pod uhlom – zrkadlový odraz sa nedostáva do pozorovacieho objektívu

Pozorovanie tvarových nepresností Si membrán

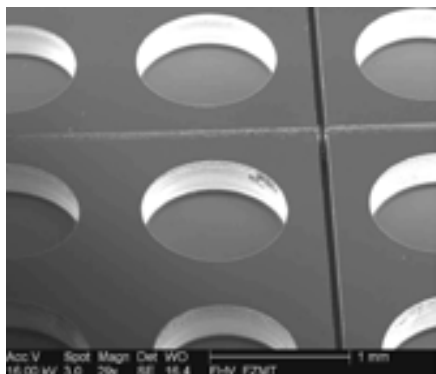
Difúzne biele šikmé osvetlenie



Meranie tvaru a veľkosti vybúlenia membránových
prvkov pod difúznym šikmým osvetlením



Optické metódy mikromechaniky

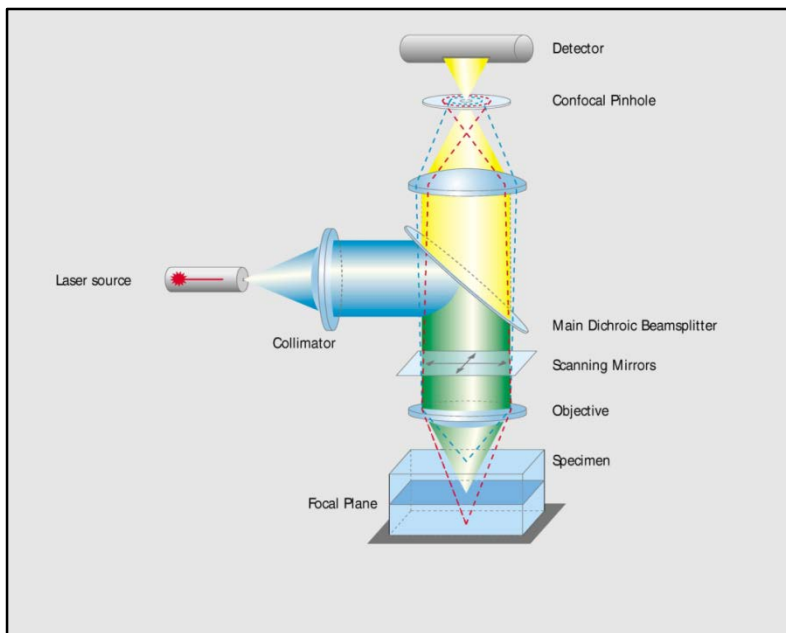


Konfokálna mikroskopia

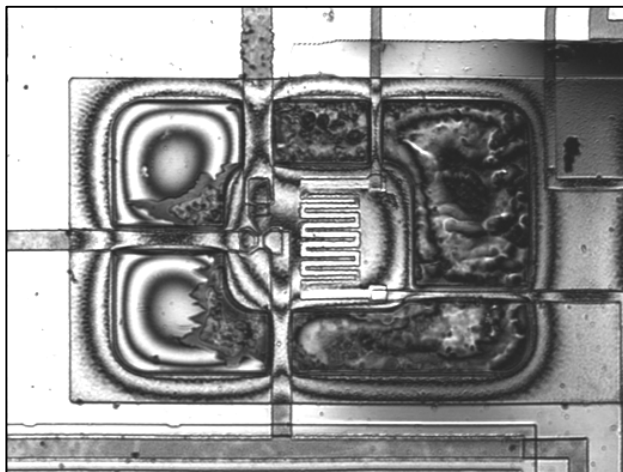
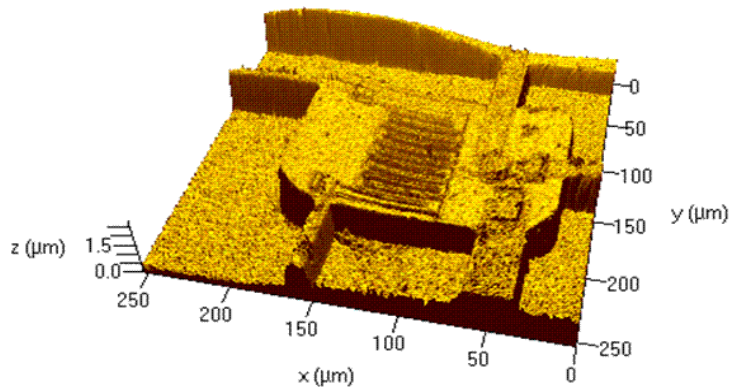
Konfokálna optická mikroskopia
- sústreďuje svetlo odrazené/vyžarované
z jednej roviny vzorky

Pinholová clona je v rovine konjugovanej
k ohniskovej rovine – iba svetlo z bodu
objektu v ohnisku môže byť zachytené
detektorom.

Laserový sfokusovaný lúč rastruje
vzorku po pixeloch v rôznych rovinách.
Obrazy vytvorené v jednotlivých rovinách
rastrovania sú skombinované do
3-D obrazu



Konfokálny mikroskop



Interferencia na tenkej vrstve

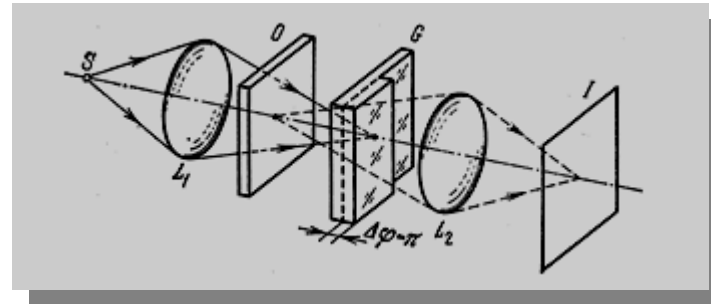
Vizualizácia fázy

Fázový objekt

$$t(x) = e^{i\phi(x)}$$

Amplitúdové filtre s meniacou sa priepustnosťou

- efekt šikmého osvetlenia
- filter s lineárne sa meniacou priepustnosťou



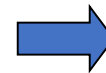
Fázový nôž

- (Zernikeho fázový kontrast)
- problém s kvantifikáciou

$$t(x) = 1 + i\phi(x) \longrightarrow \text{Fourier transform}$$

v obrazovej rovine $\Rightarrow$ variácie intenzity ukazujú fázovú štruktúru objektu

$$\psi \sim \left[\frac{2\pi f}{k} \delta(x) + i\Phi\left(\frac{kx}{f}\right) \right] \delta(y)$$



$$I_i \sim \phi^2(x)$$

optical filtration
by opaque stop

Fourier transform of $t(x)$

Shadow and phase visualization techniques

$$t(x) = e^{i\phi(x)}$$

intensity transmittance $\sim |t(x)|^2 \Rightarrow \text{constant}$

Fourier plane

$$\psi \sim \left[\frac{2\pi f}{k} \delta(x) + iT \left(\frac{kx}{f} \right) \right] \delta(y)$$

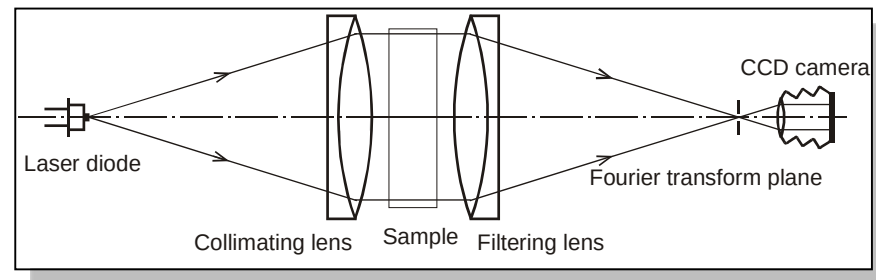
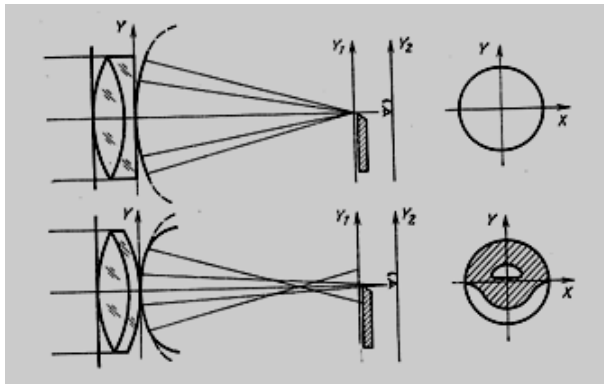
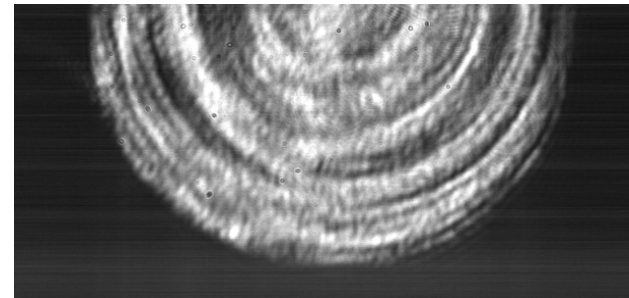
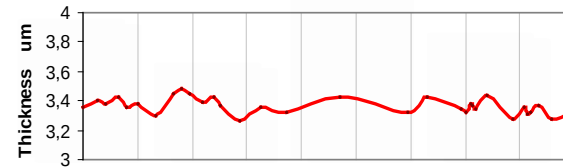
optical filtration
by opaque stop

Fourier transform of $t(x)$

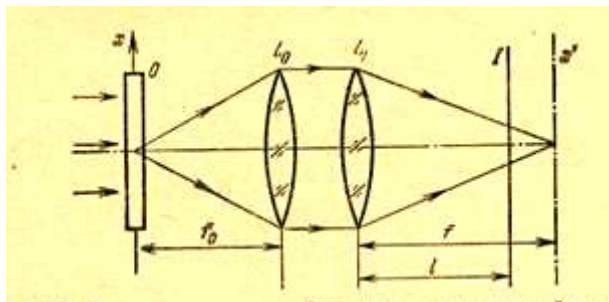
image plane

$$I_i \sim \phi^2(x)$$

intensity variation shows the nature of phase object



Fázová vizualizácia defektov – profil priehlbiny



$$b = \frac{\lambda f}{4\pi} (1 - l/f),$$

$$t(x) = \exp [i\varphi(x)],$$



rozostrenie

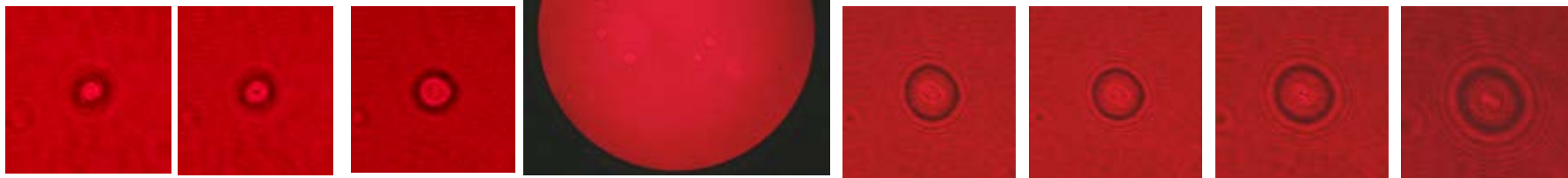
$$\int T(\omega) \omega^2 \exp(i\omega x) d\omega = -\frac{d^2 t(x)}{dx^2}.$$



Fourier transform vlastnosti

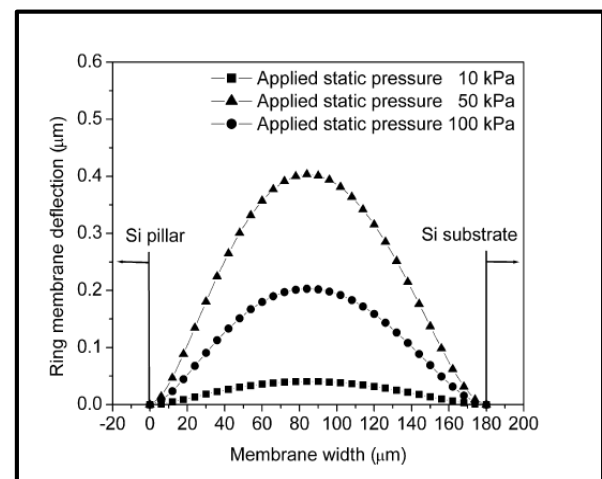
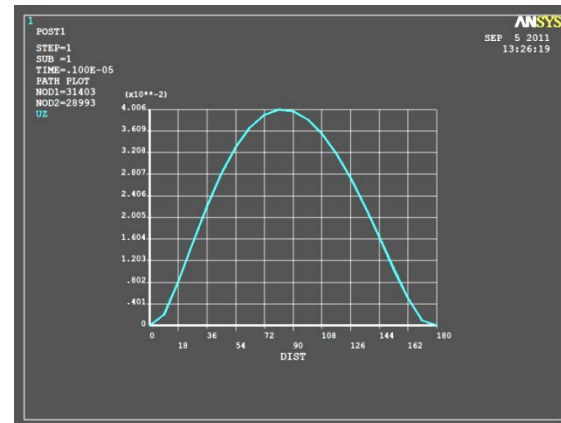
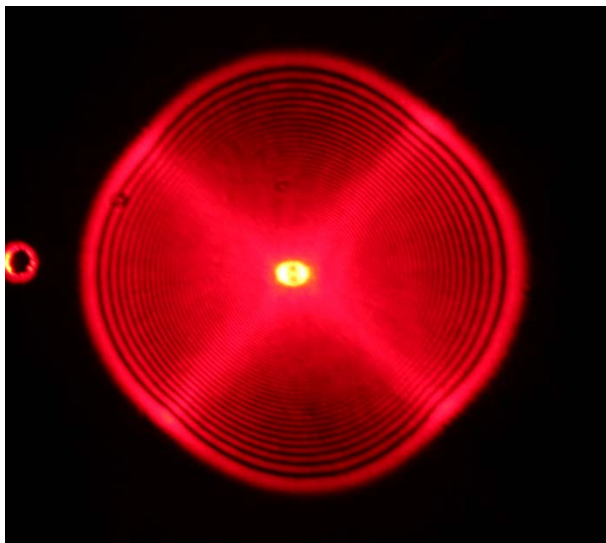
$$I_1(x) = |t_1(x)|^2 \approx 1 + 2b \frac{d^2 \varphi(x)}{dx^2}.$$

určenie hĺbkového profilu
– postupné rozostrenie



Odchýlky od sférického tvaru vybúlenia membrán

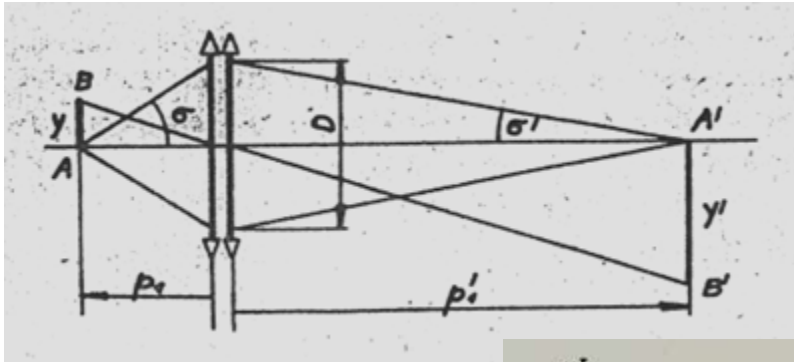
Fázová vizualizácia – anizotropia kremíka
- veľmi citlivá metóda určenia 3D odchýliek tvaru



Obraz v mikroskope – laterálne rozlíšenie

Rozlišovacia schopnosť

najmenšia vzdialenosť dvoch bodov, ktorú môžeme rozlíšiť Rayleighovo kritérium



$$y = 1,22 \frac{\lambda}{D} p_i$$

$$n y \sin \sigma = n' y' \sin \sigma'$$

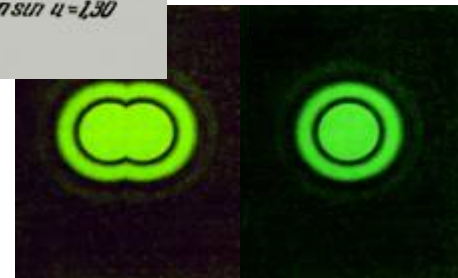
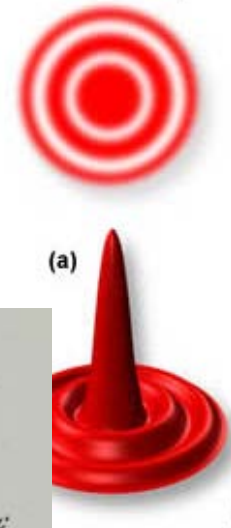
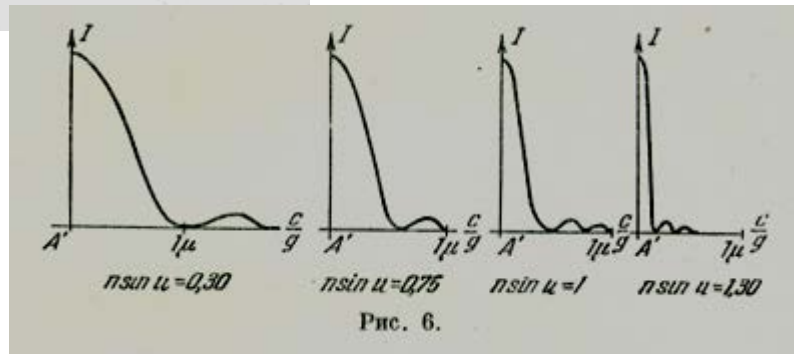
⇓

$$R = \frac{0.61\lambda}{n \sin \sigma}$$

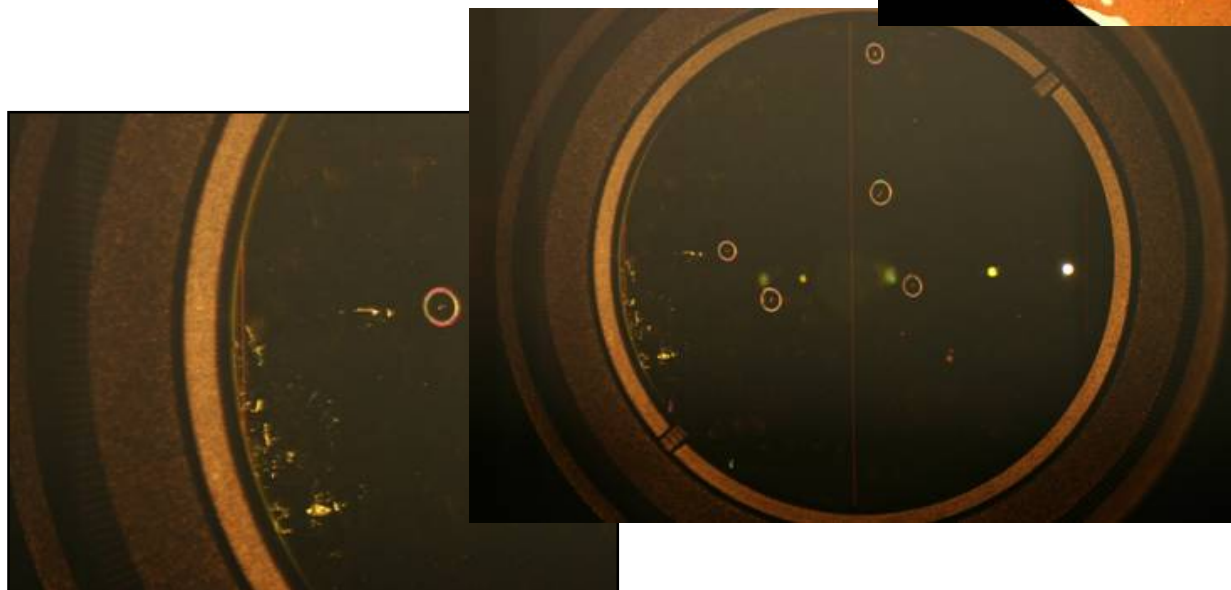
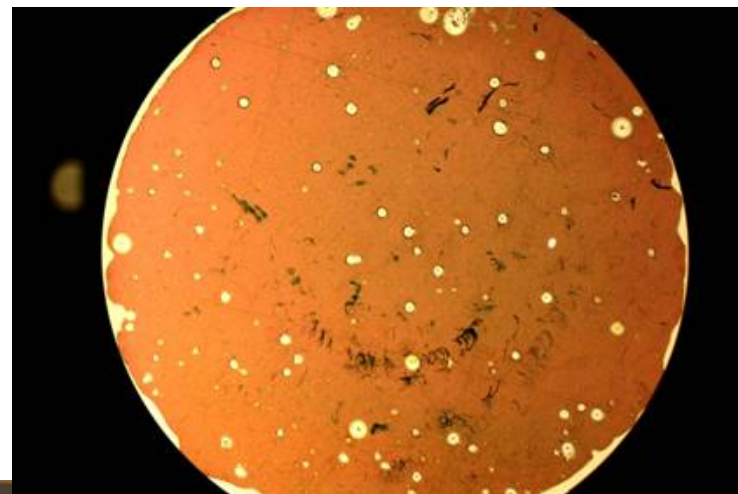
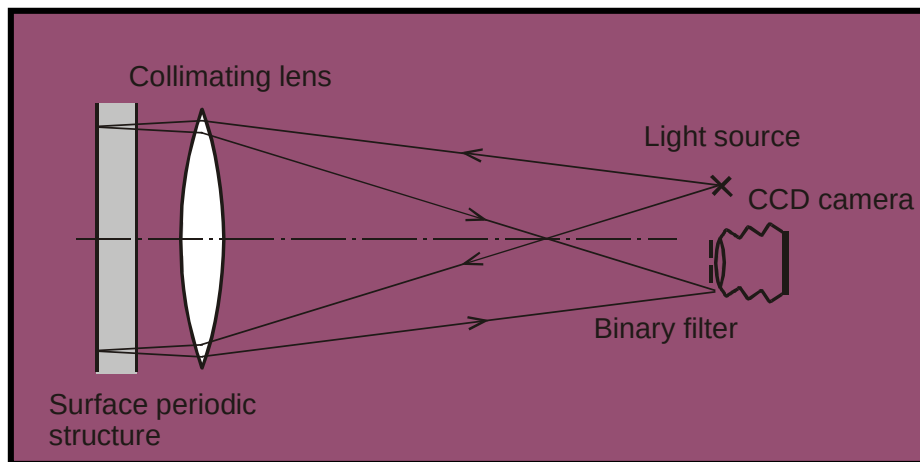
⇒

$$R = \frac{0.61\lambda}{N.A.}$$

nekoherentné svetlo

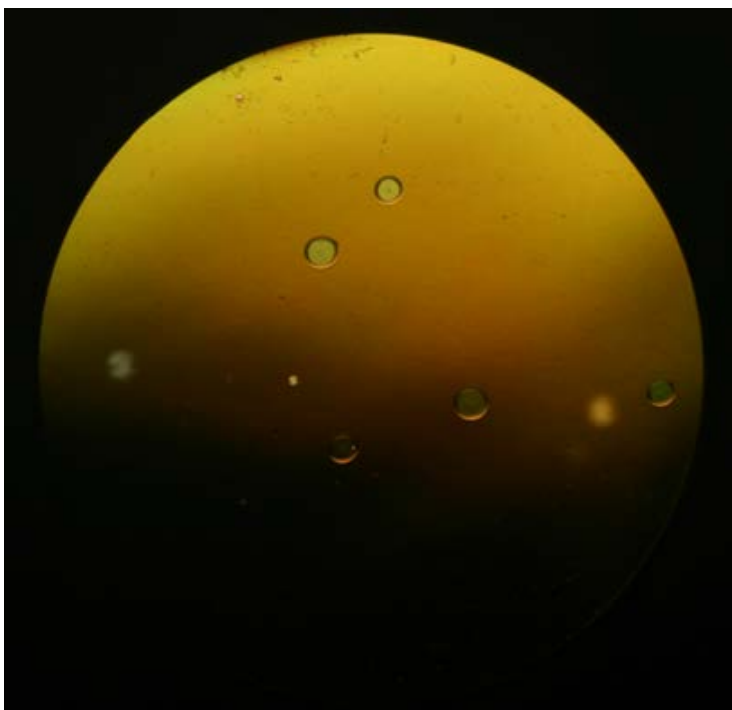


Dark-field images formed by the diffracted light around the 1st order diffraction



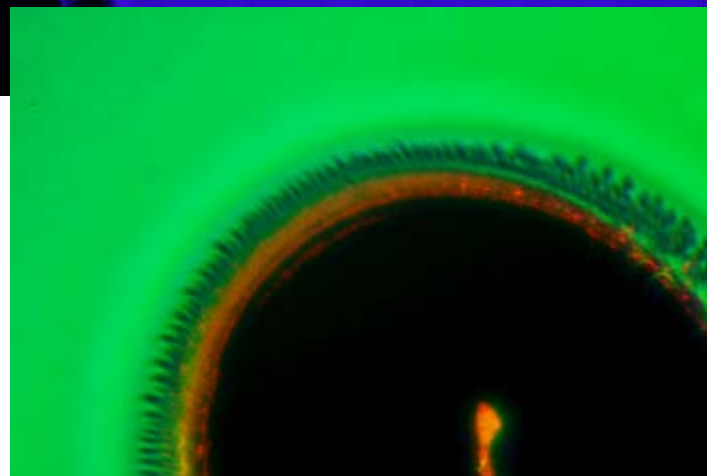
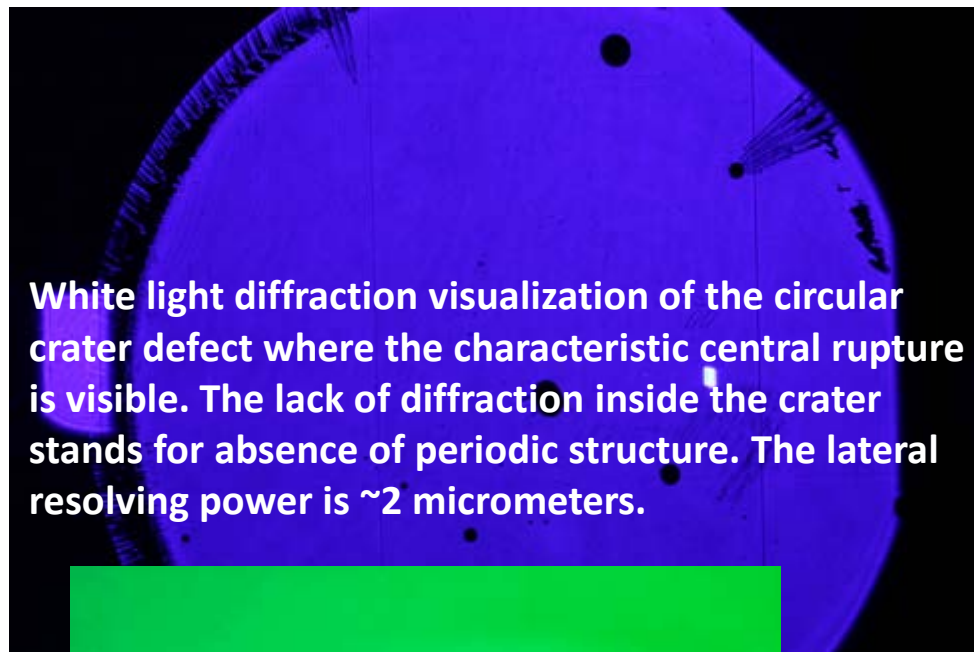
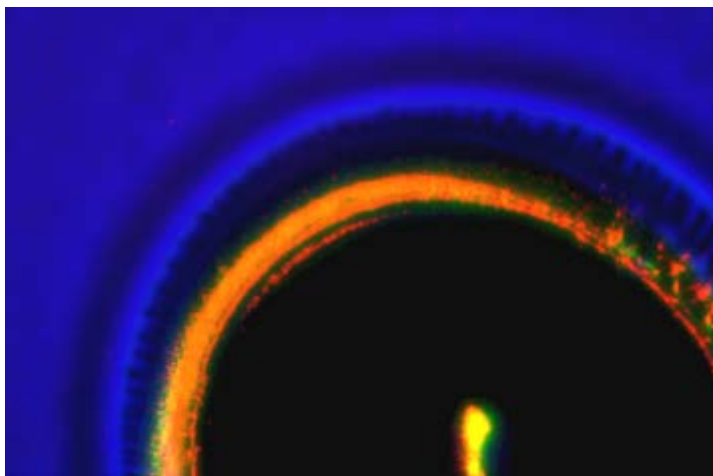
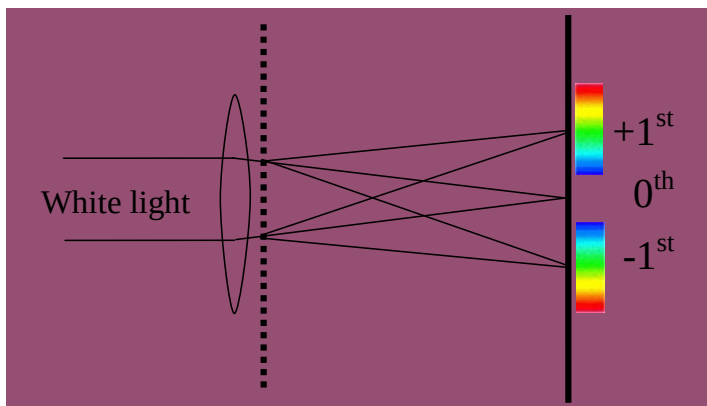
3D vizualizácia defektov vrstvy s periodickou štruktúrou

Dark-field images were formed using the binary filter opening positioned in Fourier zone diffraction. By proper adjustment of the filter position the optimum illumination conditions can be aligned with varying of the angle of illumination

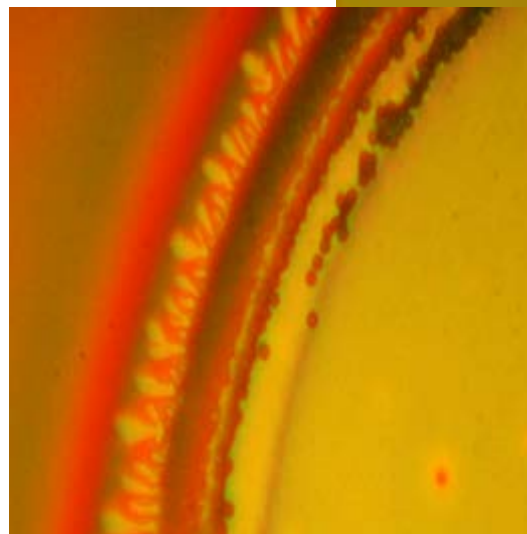
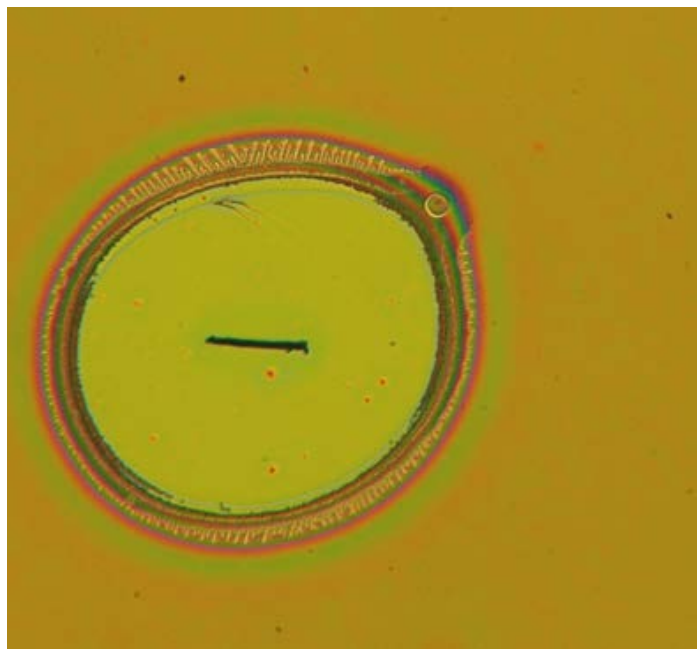
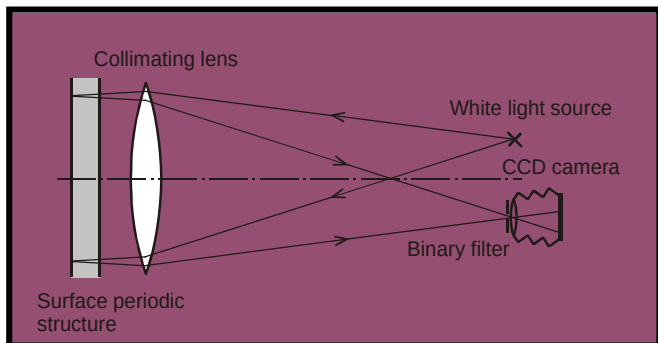


Visualization of dimple-like defects of the surface layer by grazing angle illumination. Depth of the superficial crater ~1000 nm, diameter ~1.5 mm

Inšpekcia defektov optickou filtráciou v bielom svetle



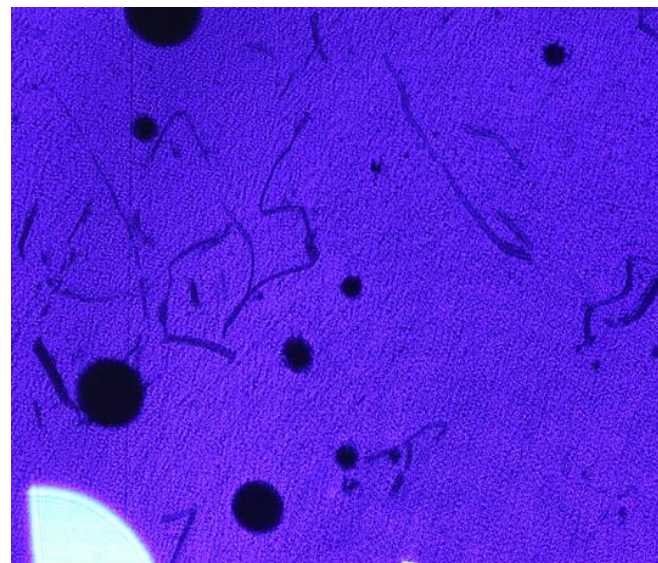
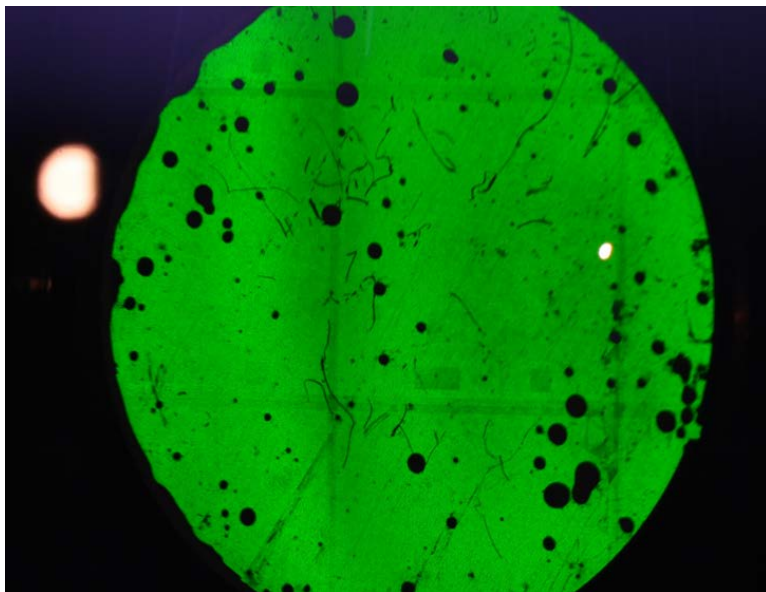
Interferencia na tenkej vrstve – svetlé pole, periodická štruktúra



Microobjective
10/0.25
 $\infty/0$

Mikroskopický obraz
laterálne rozlíšenie $\sim 1 \mu\text{m}$
hĺbkové rozlíšenie $\sim 10\text{-}20 \text{ nm}$

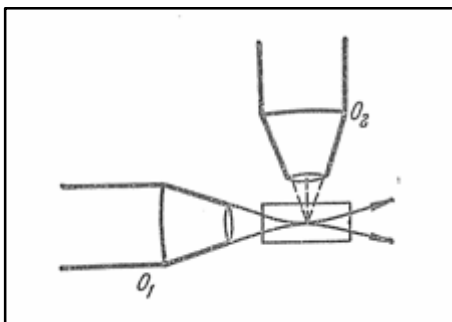
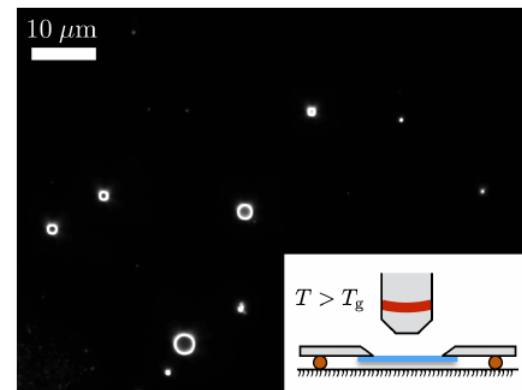
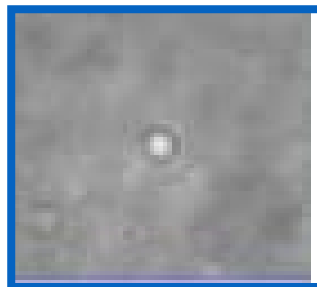
Príklady vizualizácie defektov



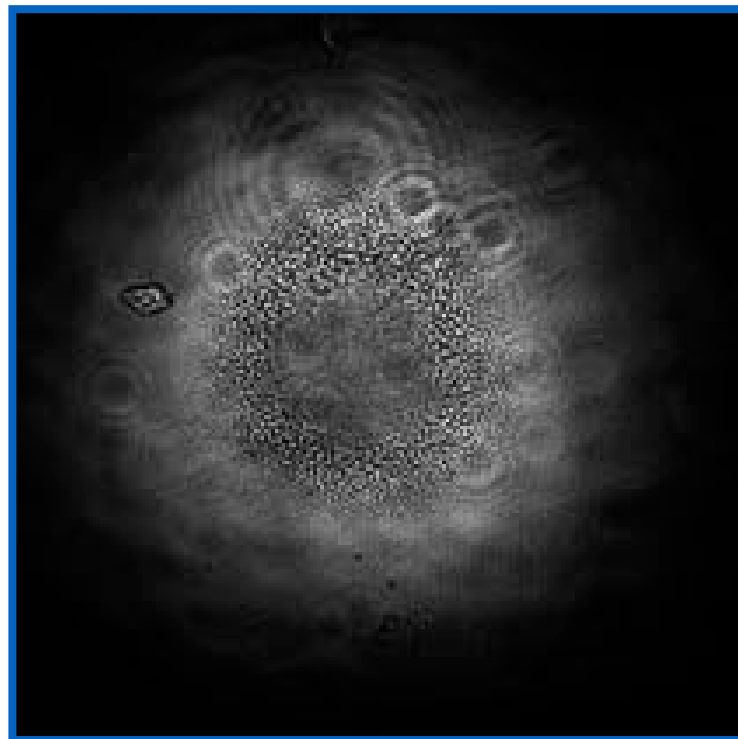
Mikro/nano-metrológia

Mikroskopické pozorovanie častíc s rozmermi pod difrakčným limitom

pozorovanie v tmavom poli
využitie rozptylu Mie
nemožno určiť tvar častice



V mikroskope možno vidieť častice
rádovo nanometrových rozmerov



CONVERTING DATA FROM PRODUCTION TO INFORMATION USING INDUSTRY 4.0

Robin Mitana¹

¹ SIDAT Digital s.r.o.

3rd INTERNATIONAL CONFERENCE

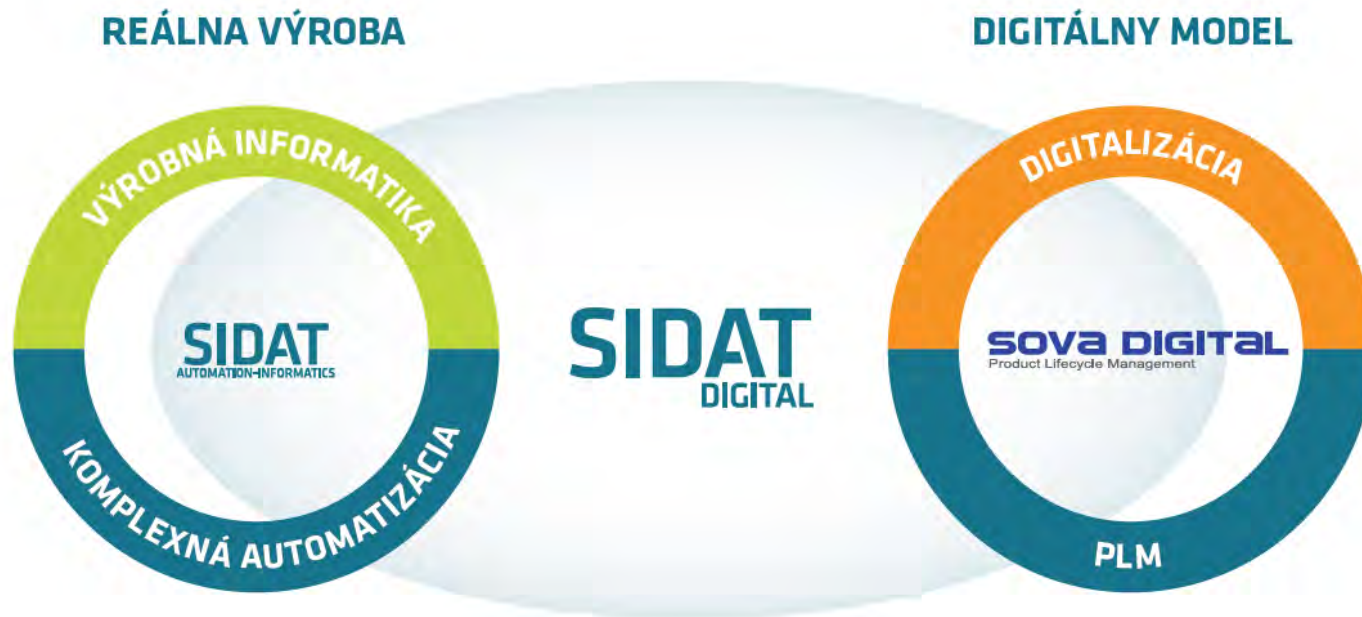
3D MEASUREMENT AND IMAGING

*MODERN CONTACTLESS MEASUREMENTS
IN INDUSTRIAL PRACTICE*

**TRANSFORMATION
OF PRODUCTION DATA TO
INFORMATIONS (I40 STRATEGY)**

Robin Mitana, robin.mitana@sidatdigital.sk, +421 903 432 036

JOINT VENTURE & SYNERGY SIDAT + SOVA DIGITAL



SIDAT DIGITAL PRODUCT PORFOLIO

CONSULTING - INCREASING THE EFFICIENCY OF PRODUCTION PROCESSES, REDUCING COSTS

MODERNIZATION OF PRODUCTION TECHNOLOGIES (ELECTRICAL & AUTOMATION) + PREPARATION FOR DIGITIZATION

DIGITIZATION OF PRODUCTION PROCESSES & LOGISTICS (RTLS)

DIGITIZATION OF ENERGY / ENERGY SOURCES

PRACTICAL IMPLEMENTATION OF INDUSTRY 4.0 SOLUTIONS

SIM - DIGITAL SIMULATION AND OPTIMIZATION OF PRODUCTION, ASSEMBLY, MACHINING, LOGISTICS, WAREHOUSING, ENERGY

VIS - VISUALIZATION OF PRODUCTION, TECHNOLOGY, BUSINESS PROCESSES

SCADA/DCS – SUPERVISORY CONTROL SYSTEMS & DATA ACQUISITION / DECENTRALISED CONTROL SYSTEMS

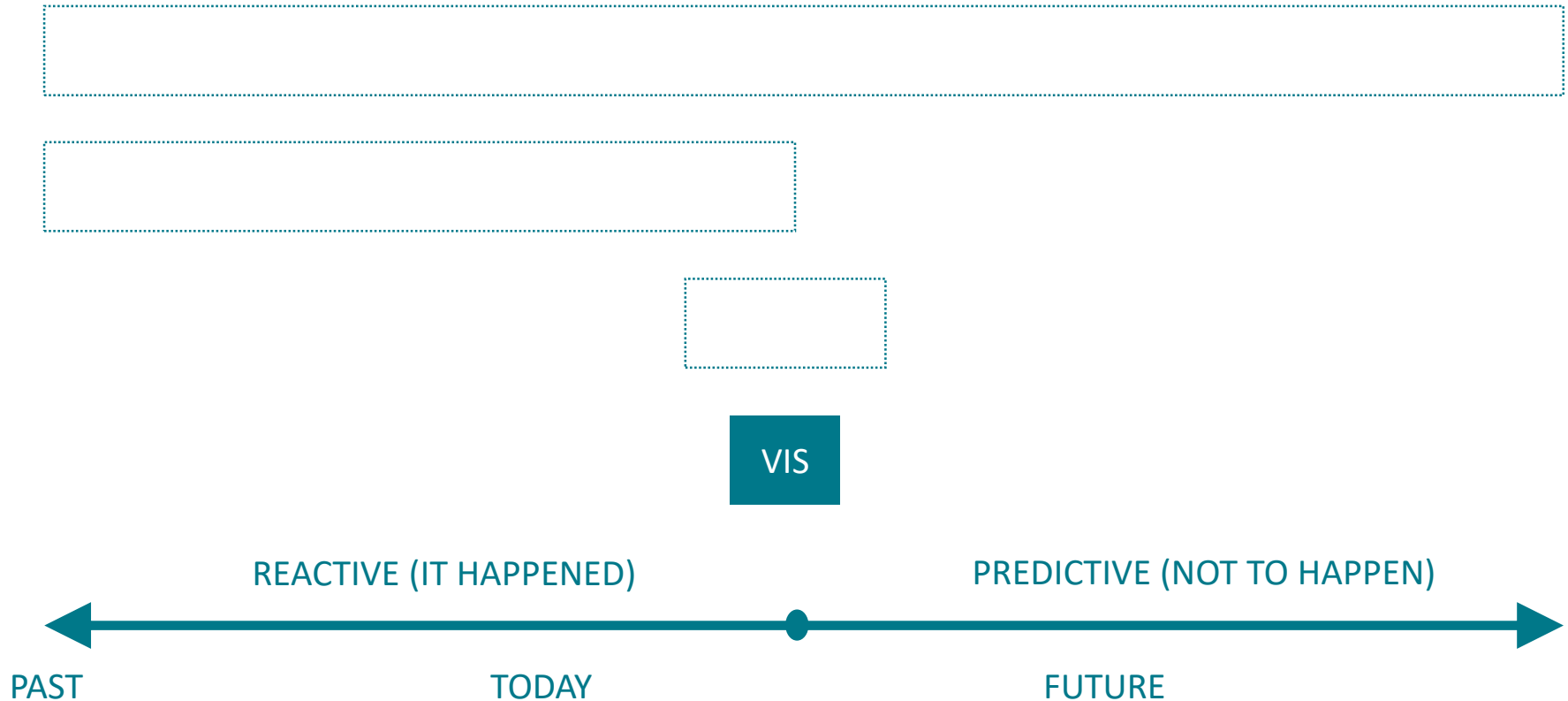
MES – MANUFACTURING EXECUTION SYSTEMS / CONVERSION OF DIGITAL DATA INTO SMART INFORMATIONS

I40/DT – CREATION OF DIGITAL TWIN & CONNECTION TO REAL PRODUCTION

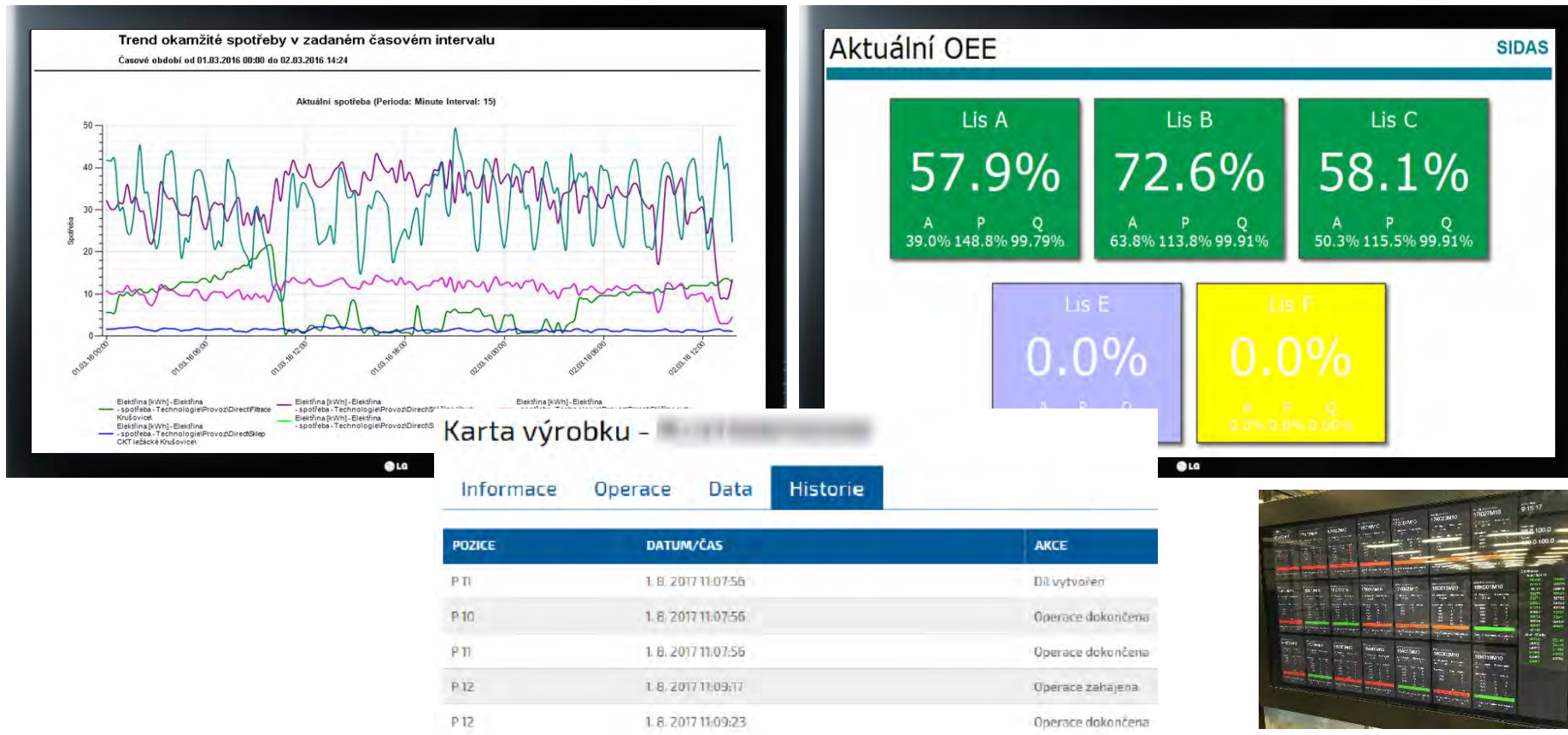
TRAINING - INDUSTRIAL AUTOMATION (PLC, OP, SW)

TRAINING – INDUSTRY 4.0 / DIGITAL TWIN + APPLICATIONS FOR INDISTRY

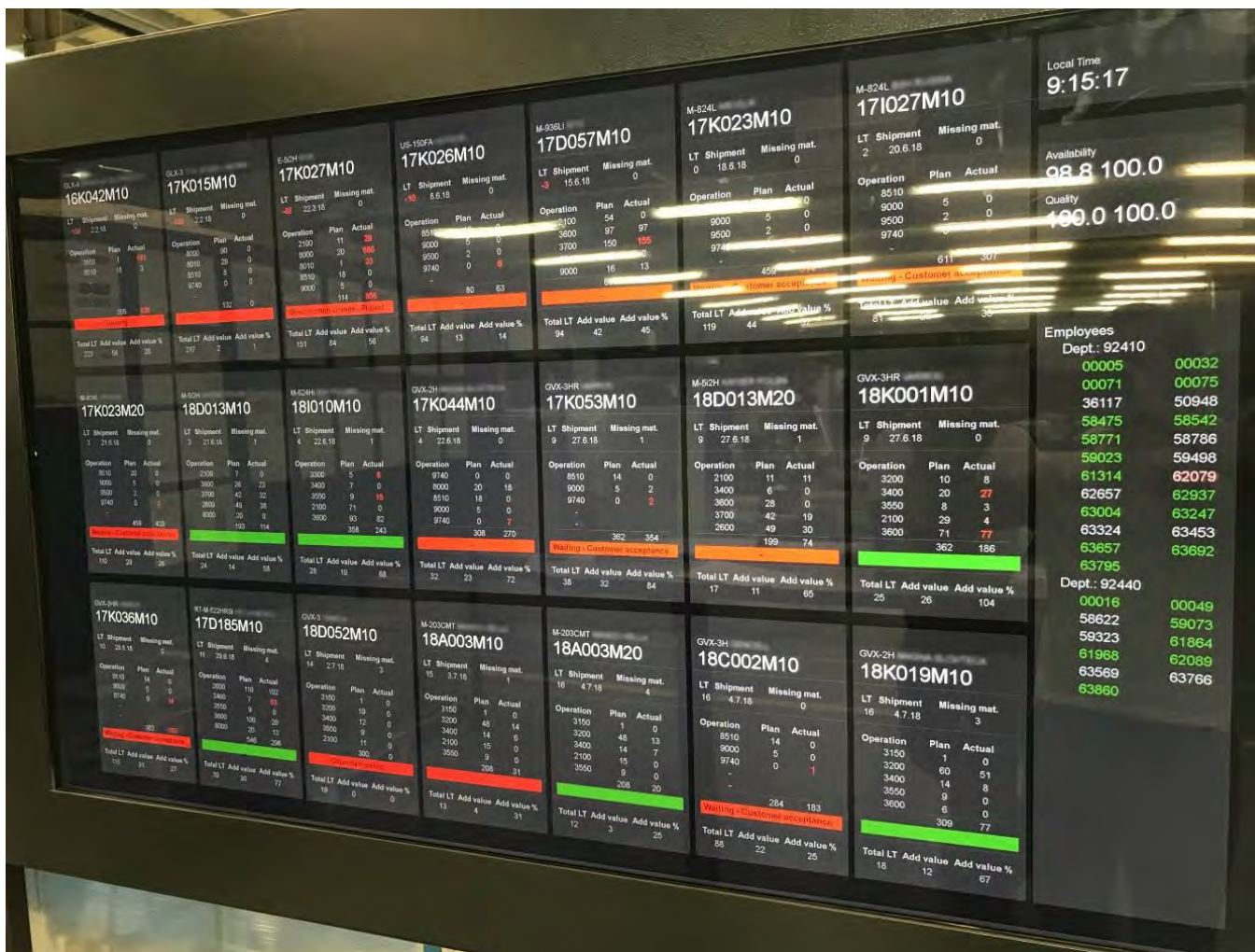
4 LEVELS OF INFORMATIONS FROM PRODUCTION



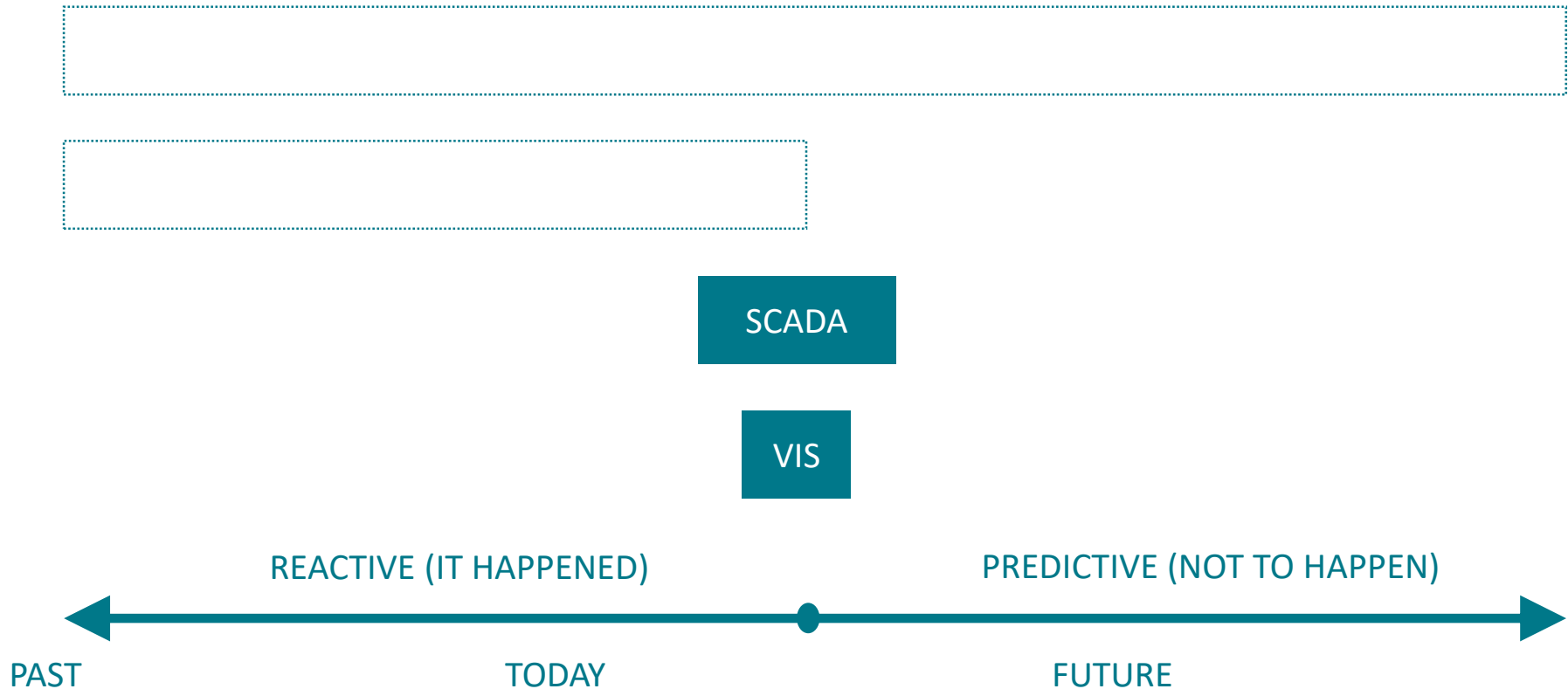
LEVEL 1 - VISUALIZATION



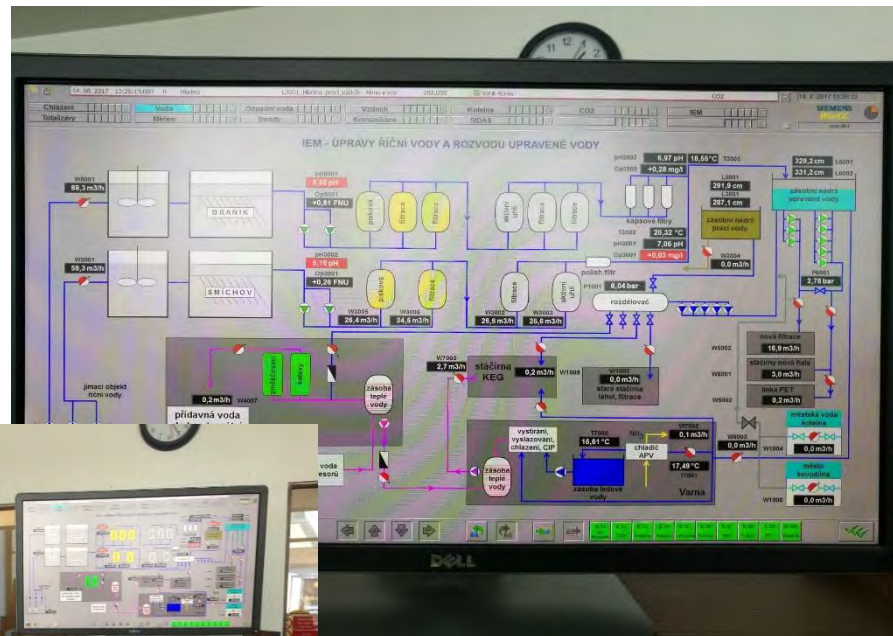
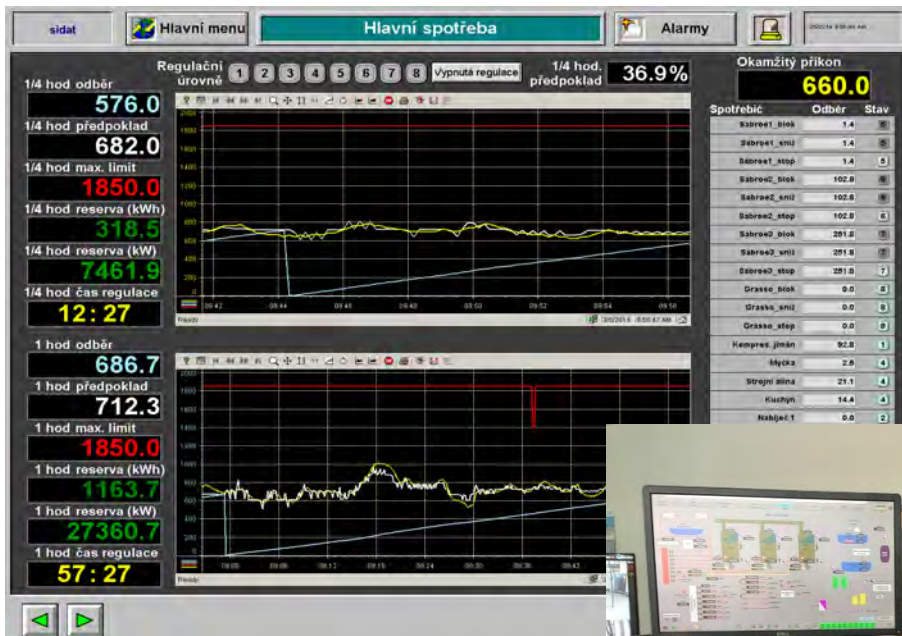
LEVEL 1 – „SMART BUSINESS“ VIZUALIZATION – ASSEMBLY CENTER



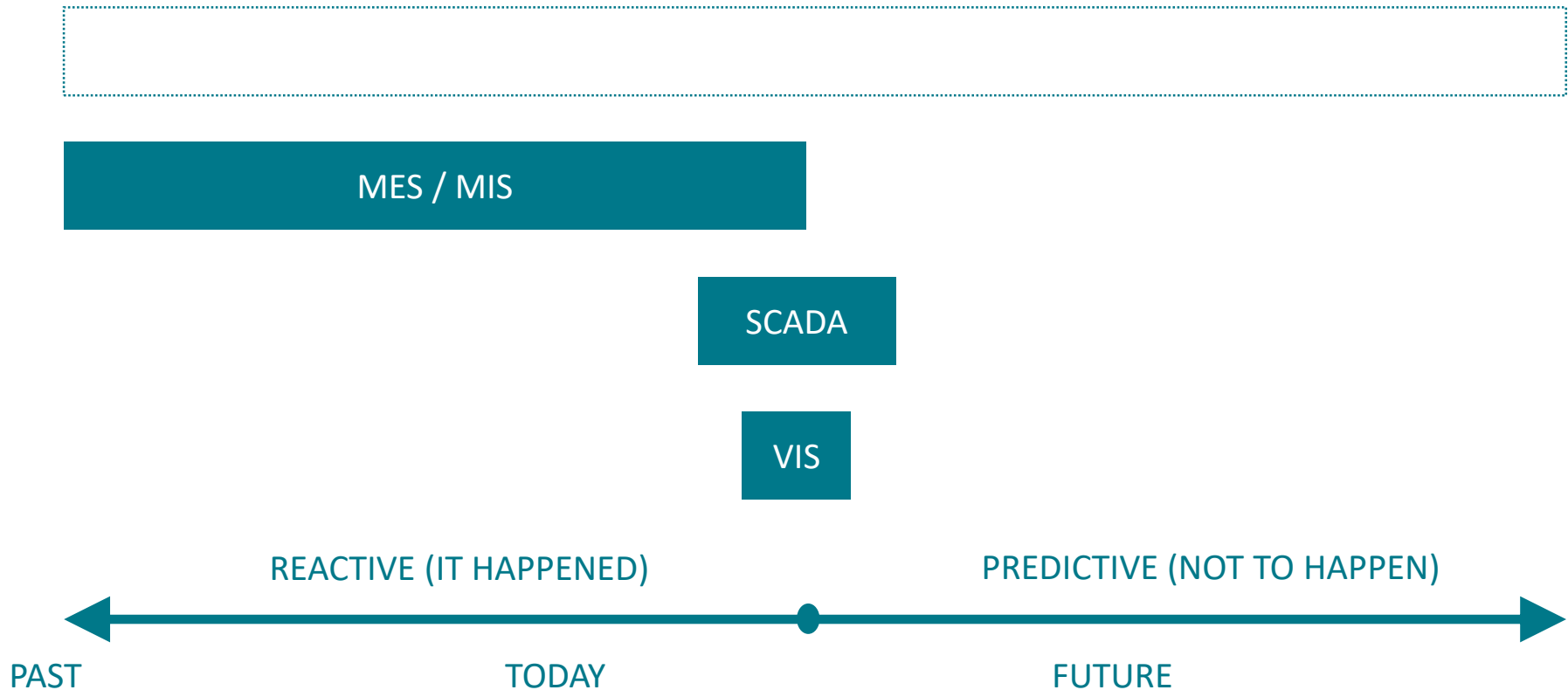
4 LEVELS OF INFORMATIONS FROM PRODUCTION



LEVEL 2 – SCADA + DCS



4 LEVELS OF INFORMATIONS FROM PRODUCTION



LEVEL 3 – MES/MIS

SBER DAT | KONFIGURACE STROMŮ | VÝROBNÍ DÍLY | MĚŘENÍ | TECHNOLOGIE | MONITORING | REPORTY | OEE | SPRÁVA UŽIVATELŮ | ODHLÁŠENÍ

Přihlášen: sidat Report - Počet zdvihů stroje/doby cyklů výroby

Zařízení: Persico 1 Datum od: 1. 6. 2016 0:00:00 Datum do: 7. 6. 2016 0:00:00 Uložit parametry Zobrazit Smazat

Report - Počet zdvihů stroje/doby cyklů výroby

Období: 01.06.2016 00:00:00 - 07.06.2016 00:00:00

Den	Zahájení výroby dílu	Ukončení výroby dílu	Číslo dílu	Celkový počet vyrobených kusů	Doba výroby 1ks dílu z BPCS [s]	Průměrný čas 1ks dílu [s]	Průměrný čas cyklu stroje [s]
01.06.2016	01.06.2016 00:00:00	02.06.2016 00:06:28	117135C	2 322	14.5	18.7	37.4
01.06.2016	01.06.2016 00:00:00	02.06.2016 00:06:28	127134C	2 322	14.5	18.7	37.4
02.06.2016	02.06.2016 01:12:50	02.06.2016 07:37:13	127146C	478	25.0	24.1	25.5
02.06.2016	02.06.2016 01:12:50	02.06.2016 07:37:13	117147C	478	25.0	24.1	25.5
02.06.2016	02.06.2016 08:52:31	02.06.2016 16:34:27	127138C	326	30.0	42.5	32.7
02.06.2016	02.06.2016 08:52:31	02.06.2016 16:34:27	127139C	326	30.0	42.5	32.7
02.06.2016	02.06.2016 16:34:35	06.06.2016 08:32:26	127134C	3 992	14.5	39.7	37.7
02.06.2016	02.06.2016 16:34:35	06.06.2016 08:32:26	117135C	3 992	14.5	39.7	37.7
06.06.2016	06.06.2016 09:04:25	06.06.2016 18:57:57	137140C	706	30.0		
06.06.2016	06.06.2016 09:04:25	06.06.2016 18:57:57	117141C	706	30.0		
06.06.2016	06.06.2016 20:02:47	07.06.2016 00:00:00	127139C	34	30.0		
06.06.2016	06.06.2016 20:02:47	07.06.2016 00:00:00	127139C	34	30.0		

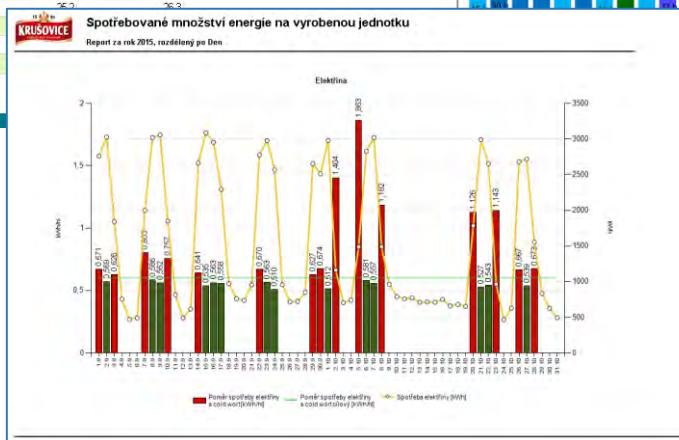
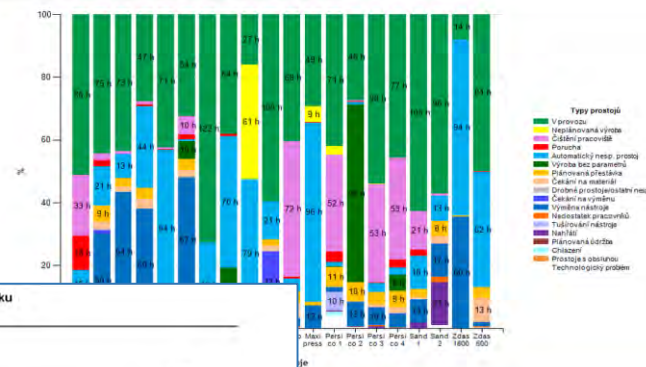
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SBER DAT | KONFIGURACE STROMŮ | VÝROBNÍ DÍLY | MĚŘENÍ | TECHNOLOGIE | MONITORING | REPORTY | OEE | SPRÁVA UŽIVATELŮ

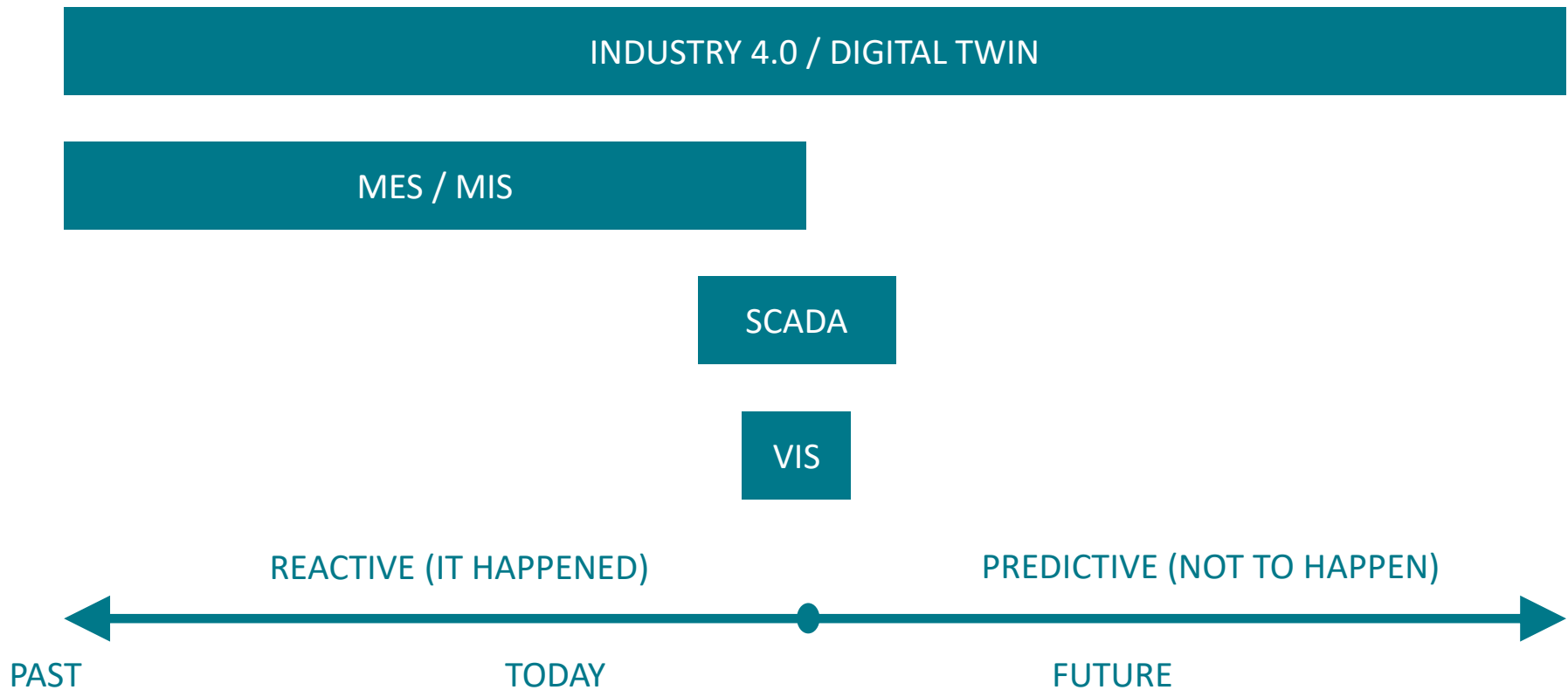
Přihlášen: sidat Report - Týdenní přehled prostojů

Zařízení: Jala M3 Rok: 2016 Týden: 24 - 13.06.2016 - 20.06.2016 Uložit parametry Zobrazit Smazat

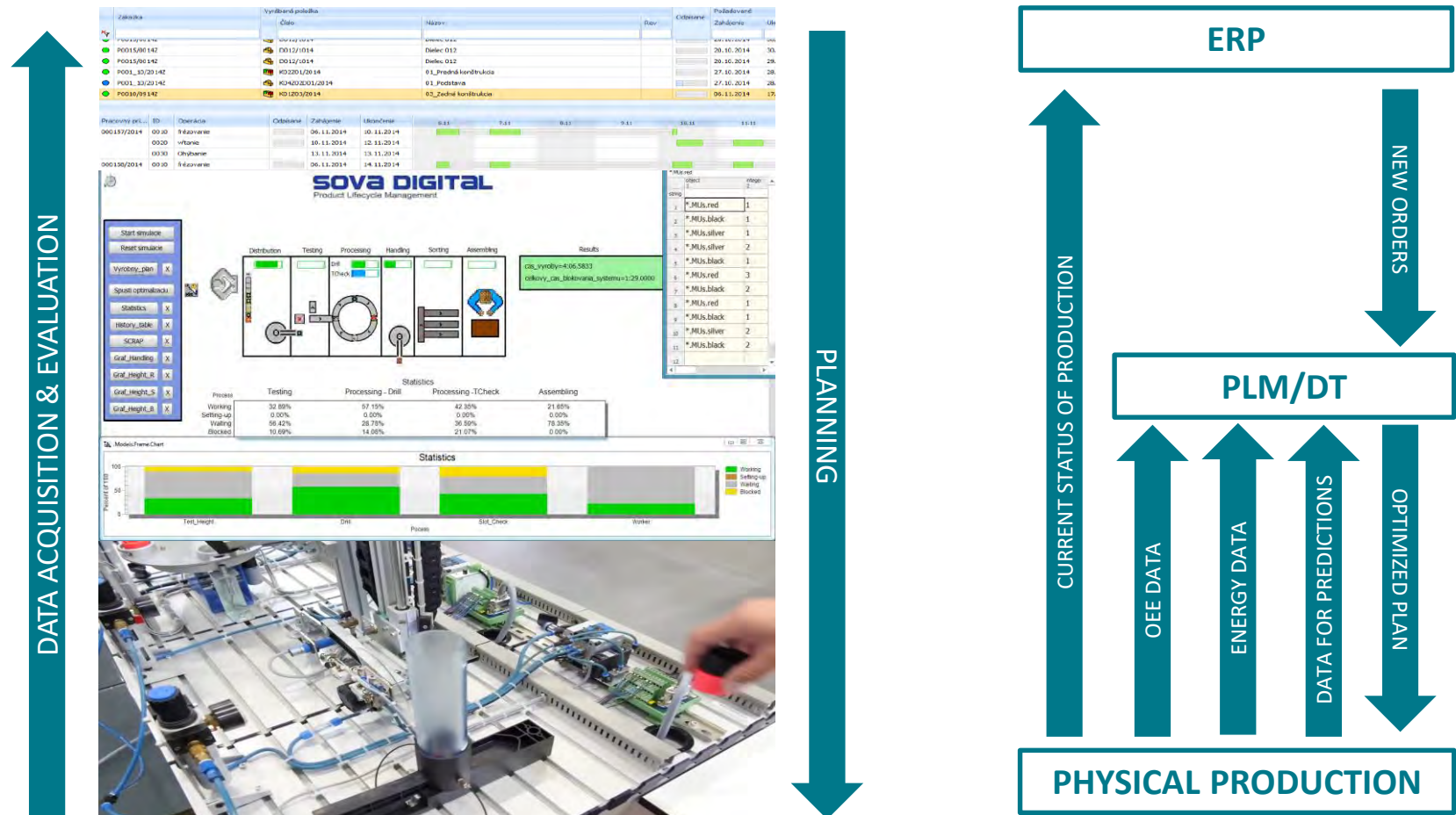
Report - Týdenní přehled prostojů pro vybrané stroje
Období: 13.06.2016 - 20.06.2016



4 LEVELS OF INFORMATIONS FROM PRODUCTION



LEVEL 4 – INDUSTRY 4.0/DIGITAL TWIN

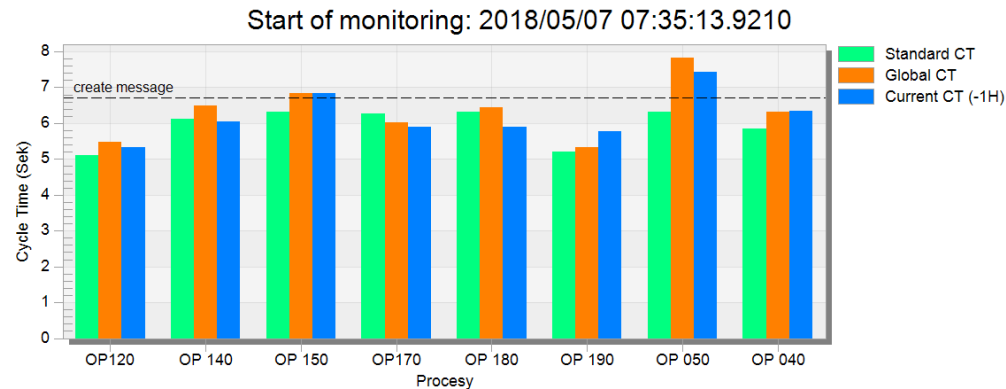


LEVEL 4 – INDUSTRY 4.0/DIGITAL TWIN - APPS

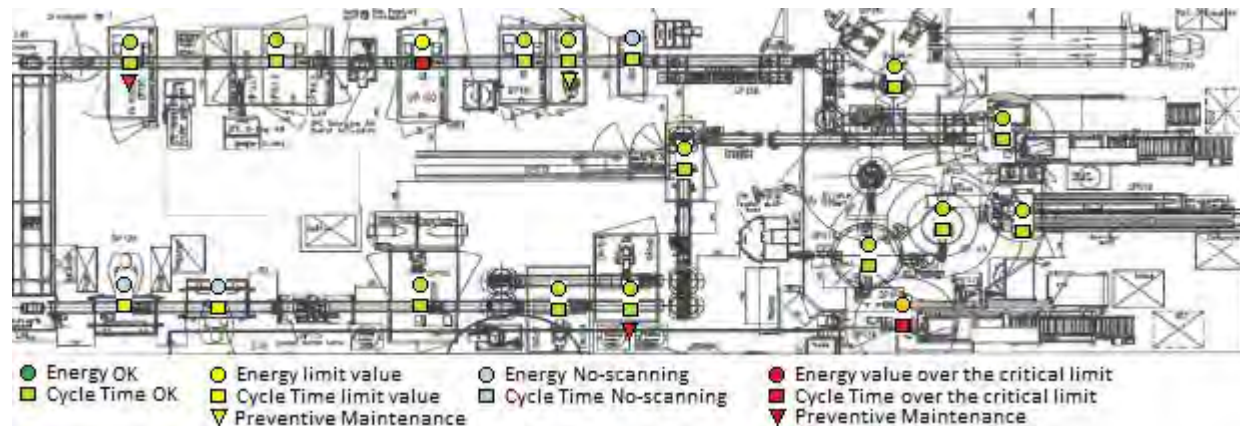
- SIMULATION & CONCEPT EVALUATION ((LINE) PRODUCTION, ASSEMBLY, MACHINING, LOGISTIC, WAREHOUSES, ENERGY, ...)
- REAL TIME PROCESS VISUALIZATION
- PROCESS REWIND „JUMP IN TIME BACK“ WHEN PROBLEM OCCURRED
- BALANCING OF PRODUCTION RESOURCES
- CYCLE TIMES MONITORING FOR BETTER PLANNING
- DOWN-TIMES & MICRO DOWN-TIMES / DELAYS & MICRO-DELAYS IDENTIFICATION
- PREDICTIVE LOGISTIC – AUTOMATIC REQUIREMENTS FOR LOGISTIC
- PREDICTIVE REAL TIME QUALITY MONITORING
- PREDICTIVE MAINTENANCE BASED ON REAL TIME RESOURCES MONITORING
- ADVANCED PLANNING (APS) FOR OPERATIVE (EACH DAY) PRODUCTION PLANNING
- OTHERS ... DIGITAL TWIN SW PLATFORM IS ALMOST WITHOUT LIMITS

LEVEL 4 – INDUSTRY 4.0/DIGITAL TWIN SMART OUTPUTS (EXAMPLES)

CYCLE TIME STABILITY ANALYSE



SMART PRODUCTION DASHBOARD



INDUSTRY 4.0 PATH

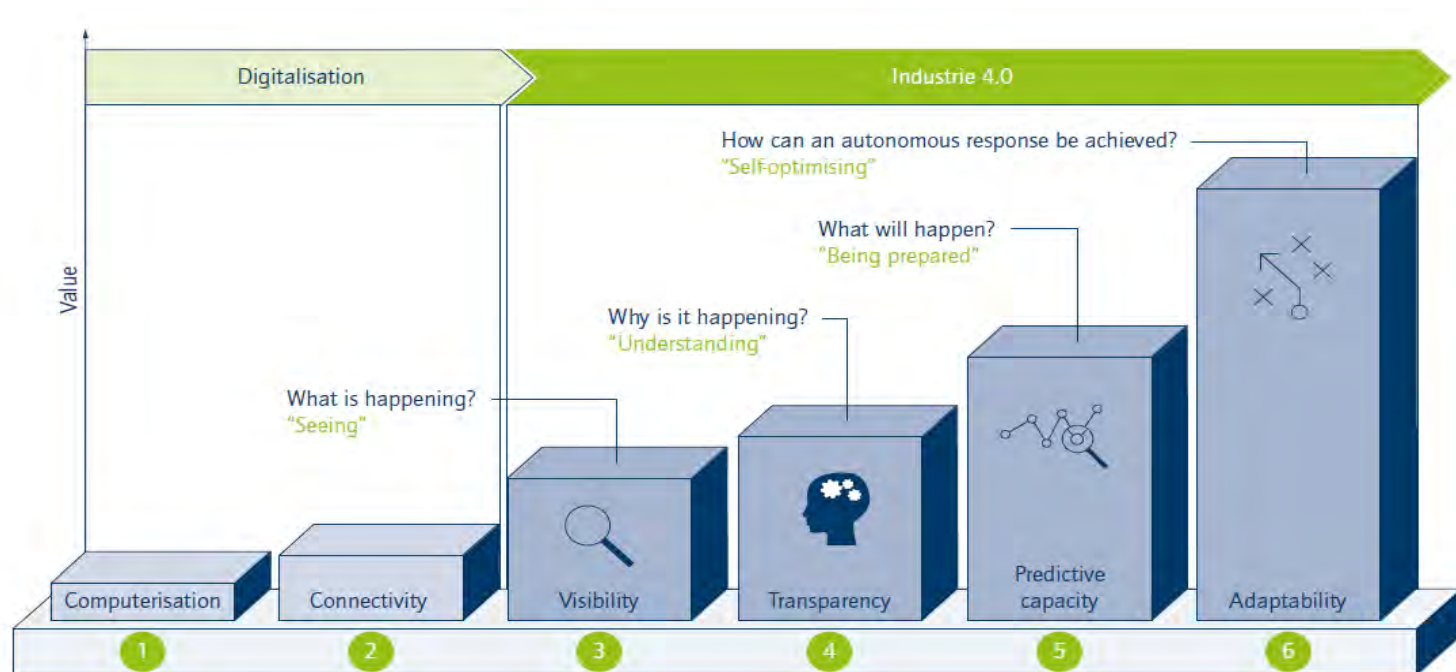
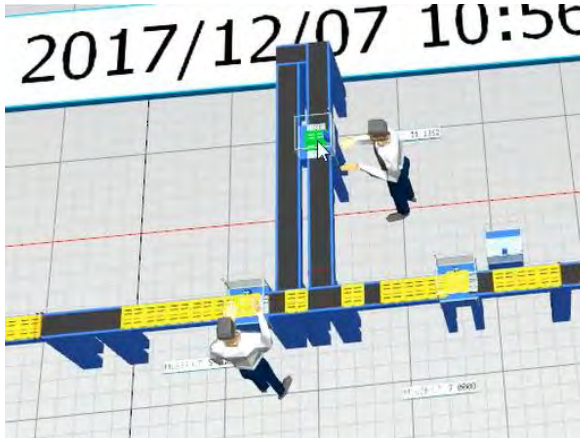


Figure 5: Stages in the Industrie 4.0 development path (source: FIR e. V. at RWTH Aachen University)

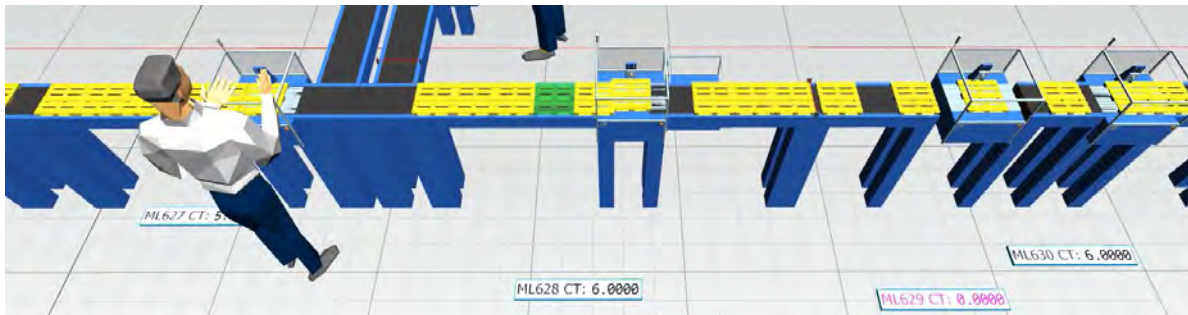
I40/DD –OEE IMPROVING FOR LINE PRODUCTION



DIGITÁLNE DVOJČA



FYZICKÁ LINKA



REALIZED I40/DD APPLICATIONS

PUBLISHED WITH APPROVAL OF
EMBRACO SLOVAKIA FOR SOVA DIGITAL

VISUALIZATION OF CURRENT STATUS OF
PRODUCTION

REAL CYCLE TIMES

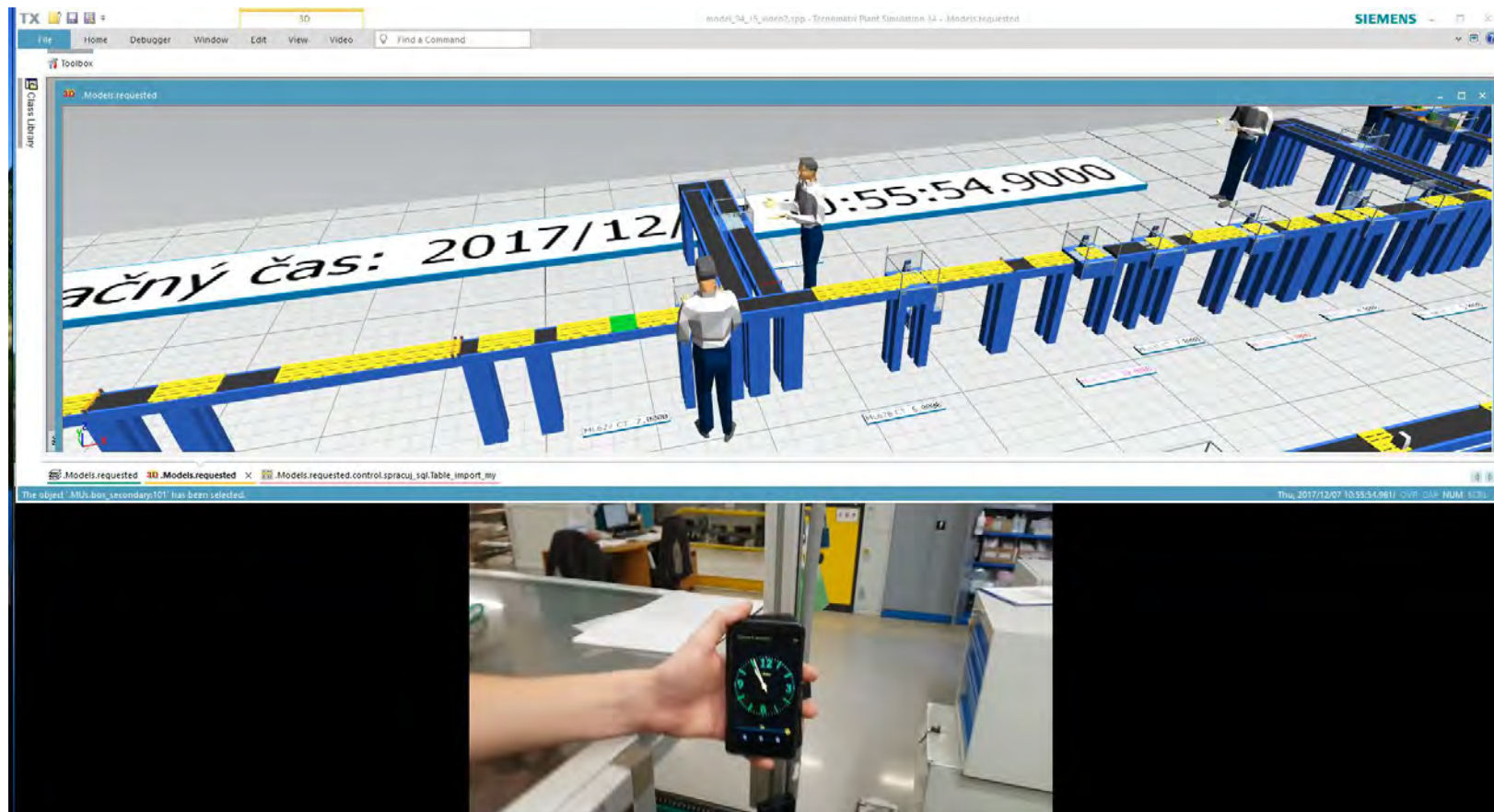
REAL UTILISATION OF RESOURCES

IDENTIFICATION OF DELAYS & MICRO-
DELAYS + DOWNTIMES & MICRO-
DOWNTIMES

COLLECTED & EVALUATED APPROX.
800000 LINES OF INFORMATIONS PER
SHIFT

IMPROVED OEE BY +3% (APPROX.
+300PCS) = APPROX. +1MIL EUR/YEAR
BENEFIT

I40/DD –OEE IMPROVING FOR LINE PRODUCTION



The screenshot displays a simulation software interface for a material handling system. The main window shows a top-down view of a complex layout with conveyor belts, storage areas, and various equipment. The simulation time is 2018/04/09 08:04:54.6000. The interface includes a top menu bar, a left sidebar with navigation options, and a main simulation area. Various components are labeled with IDs and CT values, such as ML616 CT: 7.0000 and ML616 CTR: 6.32. The layout is divided into sections by color-coded lines and includes a detailed control panel on the left.

THANK YOU

Robin Mitana,
robin.mitana@sidatdigital.sk
+421 903 432 036

RADAR USAGE FOR TRANSPORT AND INDUSTRY

Ing. Lukáš Maršík ¹

¹ Camea image & signal processing

Abstract

In CAMEA traffic monitoring and industry systems, the use of radar has many advantages. It can generate information about immediate speed of multiple objects and their distance and angular position in the scene. As well, radar performance is nearly not affected by amount of light or bad weather conditions. Thus, it can well supplement current video-detection systems with new information that can significantly improve reliability and success rate of the detection.

3rd INTERNATIONAL CONFERENCE

3D MEASUREMENT AND IMAGING

*MODERN CONTACTLESS MEASUREMENTS
IN INDUSTRIAL PRACTICE*

USING RADAR IN TRAFFIC
AND INDUSTRY SYSTEMS



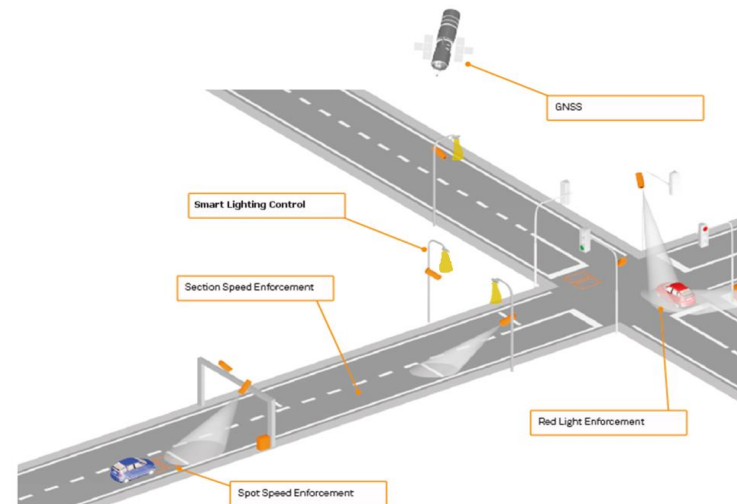
Lukáš Maršík (l.marsik@camea.cz)

CAMEA IMAGE & SIGNAL PROCESSING

- Founded in 1995 by a group of researchers
- Located in BRNO (CZ), currently 70+ employees
- Focus on industrial and traffic applications
- R&D, manufacturing, selling, servicing, maintenance of components, systems, custom solution
- Has produced and deployed around the world hundreds of visual systems with thousands of video cameras and real-time processing units

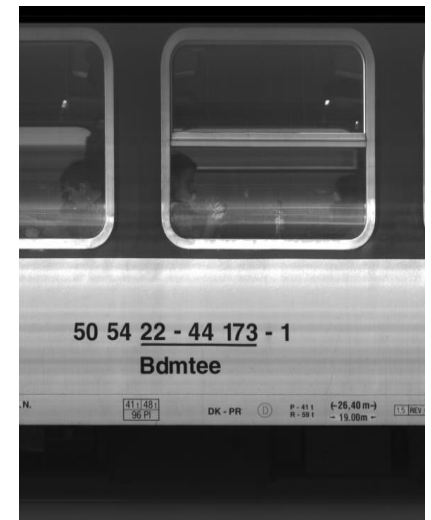
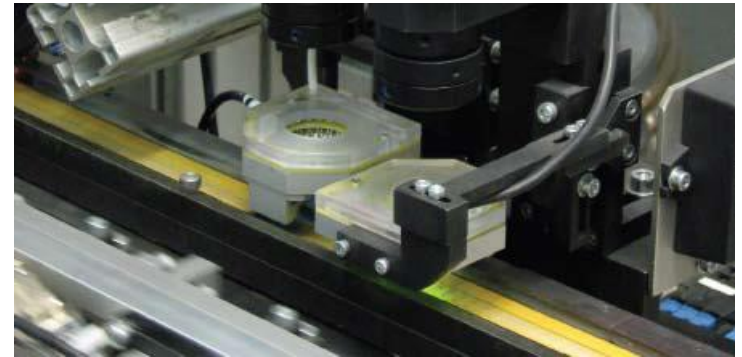
CAMEA'S ITS SYSTEMS

- UNICAM platform
- Weigh-In-Motion
- Enforcement Systems
- Traffic Monitoring
- Vehicle Identification
- ITS Technologies



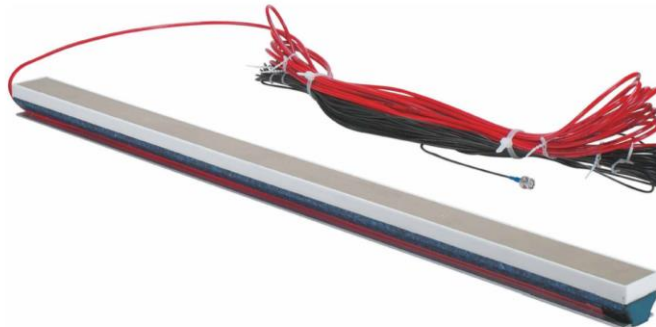
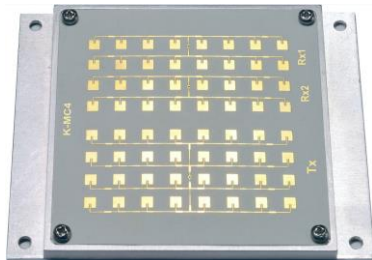
CAMEA'S INDUSTRY SYSTEMS

- Web Inspection
- Bottle Inspection
- Component Inspection
- Laser Beam Deflector
- 3D reconstruction
- Label Inspection
- Automatic identification of railway carriages



SENSORS IN CAMEA SYSTEMS

- Video cameras (optionally with IR flashes)
- Induction loops
- Laser scanners
- Piezoelectric sensors
- FMCW radars



RADAR IN CAMEA SYSTEMS

- Mobile multi-lane enforcement system
- Spot speed enforcement
- Camera triggering
- Vehicle presence detection
- Vehicle counting (statistics)
- Train speed recording



FMCW RADAR FUNDAMENTALS

- Frequency Modulated Continuous Wave
- Waves transmitted and reflected (or absorbed)
- Doppler frequency - speed measurement
- Frequency Modulation - distance measurement
- MIMO technique - angular position

RADAR ADVANTAGES

- Direct speed measurement
- Distance and angle position measurement
- Independence on daylight
- Very low influence of bad weather condition
- Can be installed as hidden
- No problem with GDPR

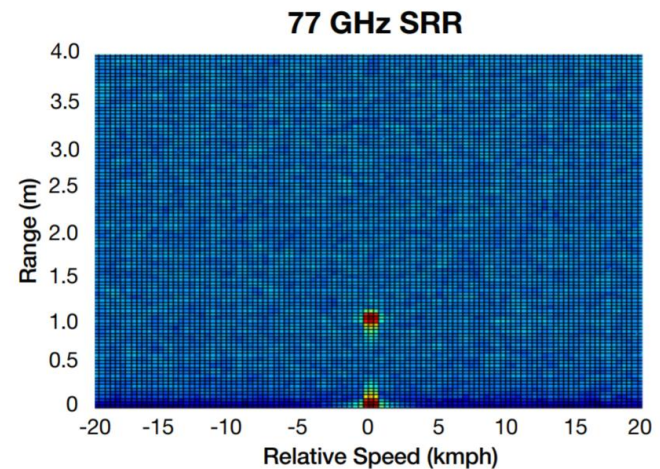
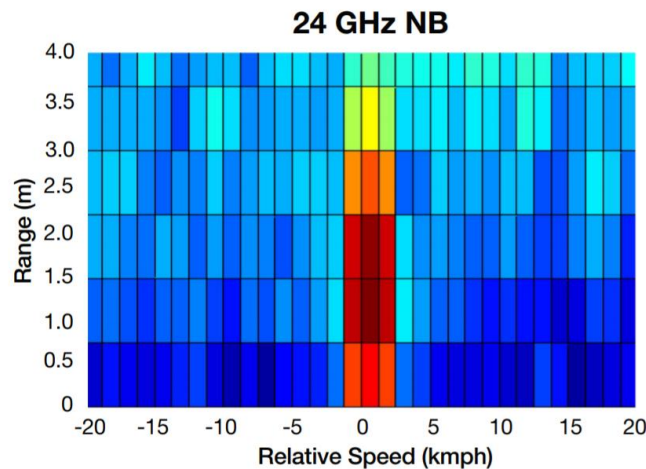
RFBEAM K-MC4

- 24GHz **analog** radar module
- FMCW (ISM - 250MHz)
- Speed or/and range
- Angle measurement
- Separate embedded processing



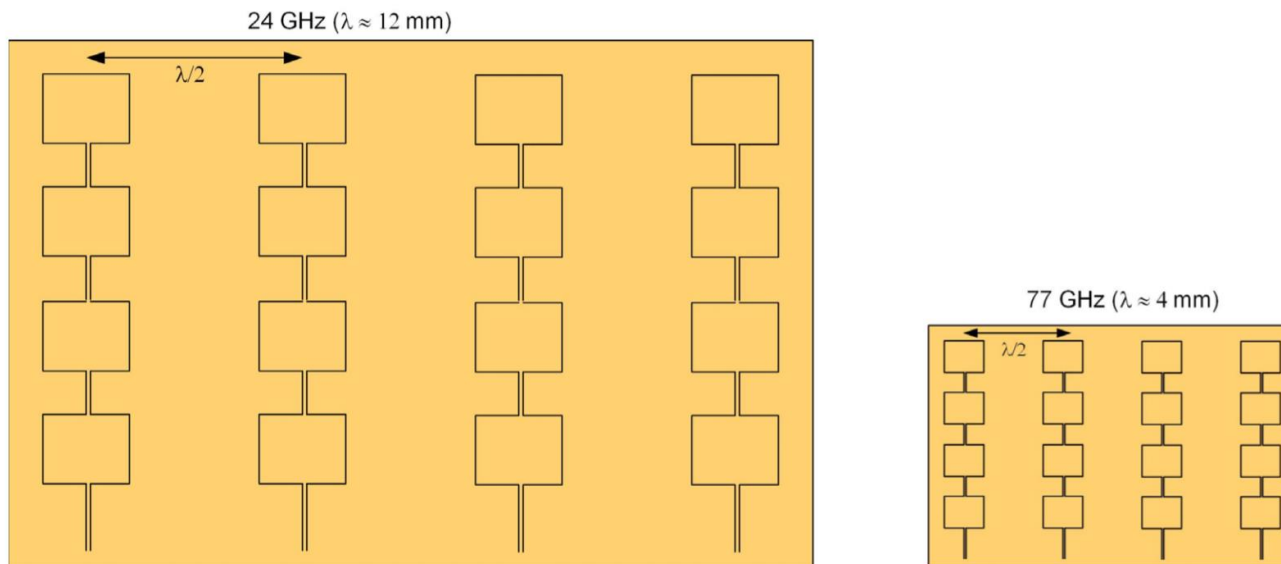
FROM 24GHZ TO 77GHZ

- Bandwidth (legacy 250MHz / UWB 5GHz)
 - 1GHz (76-77GHz LRR) / 4GHz (77-81GHz SRR)
- ~20x better range resolution, 3x better velocity resolution



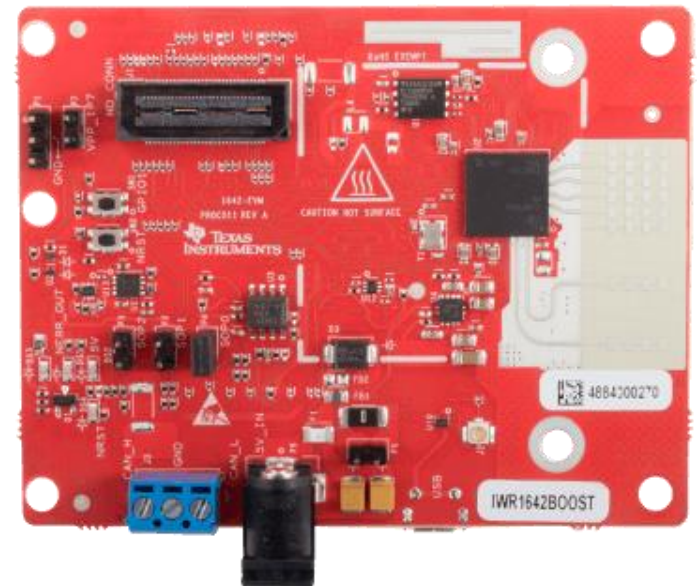
FROM 24GHZ TO 77GHZ

- 3x smaller form factor
 - narrower (more focused) beam
 - small final system (automotive, drones, ...)

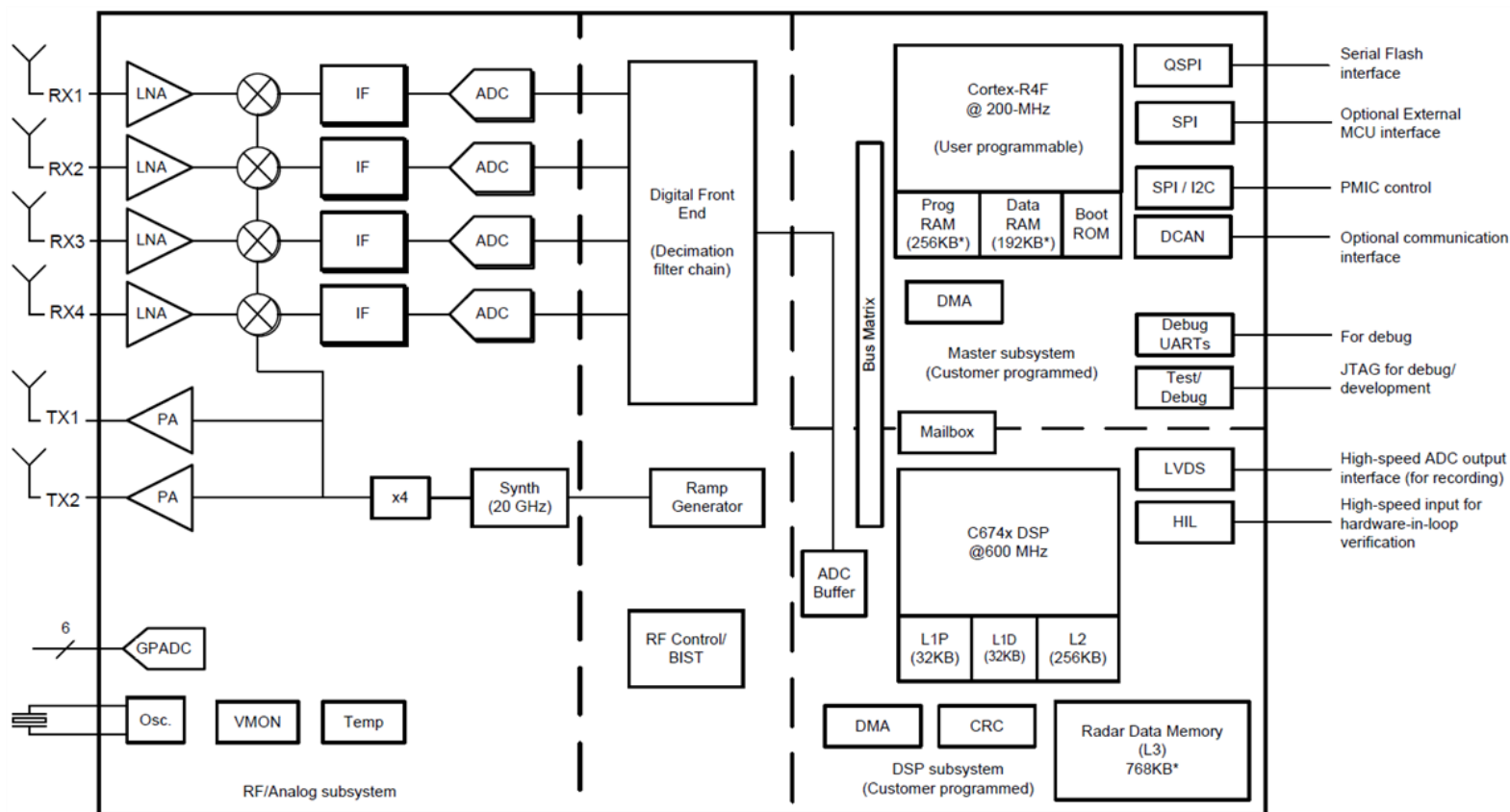


TI IWR1642BOOST

- Radar-on-chip solution
- Processing fast ramps (2D FFT's)
- Sampling frequency 5Ms/s
- Distance / velocity / angle
- TI launchpads compatible
- Ethernet capture card
- Price 299\$

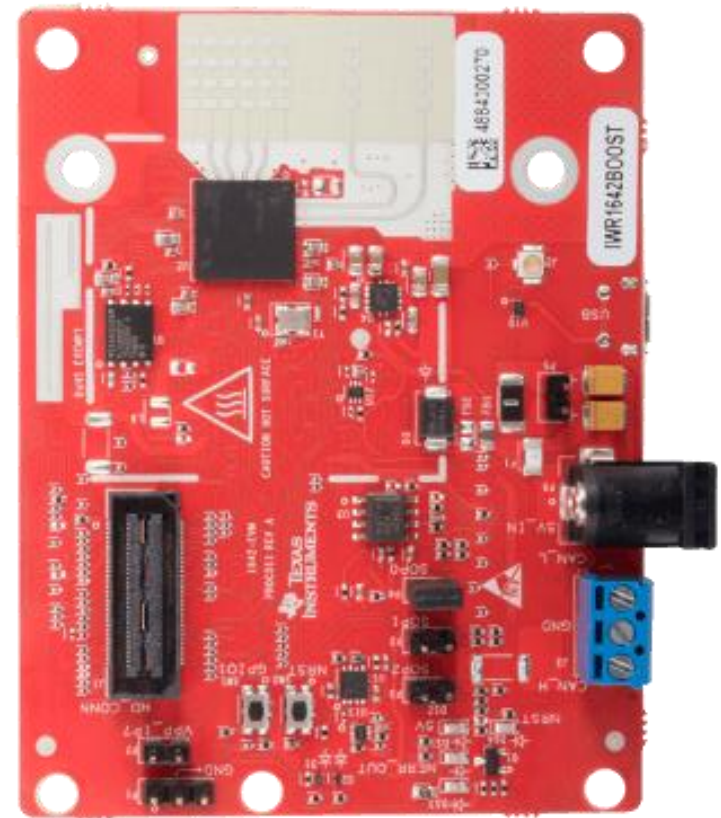
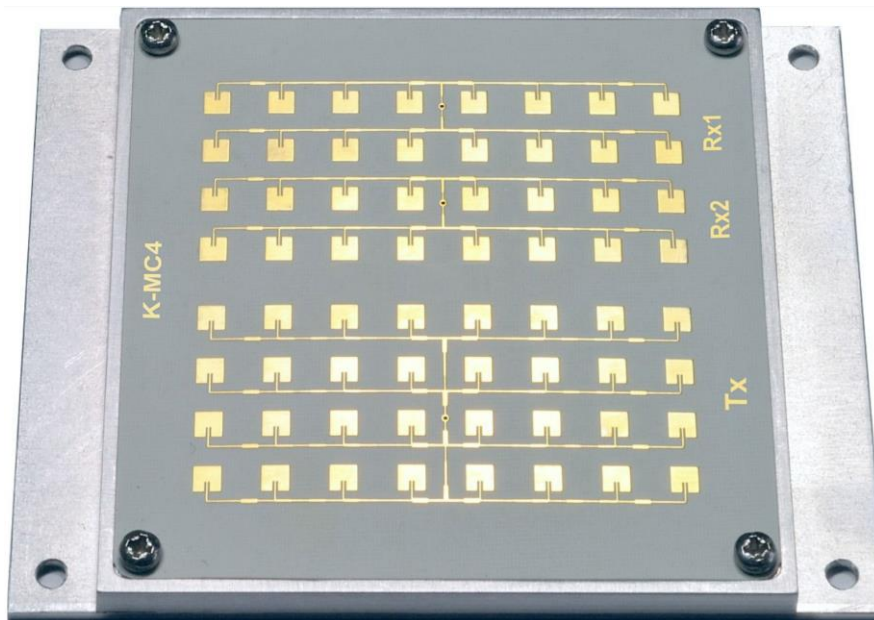


TI IWR1642



* Up to 512KB of Radar Data Memory can be switched to the Master R4F if required

TI IWR1642BOOST VS. K-MC4



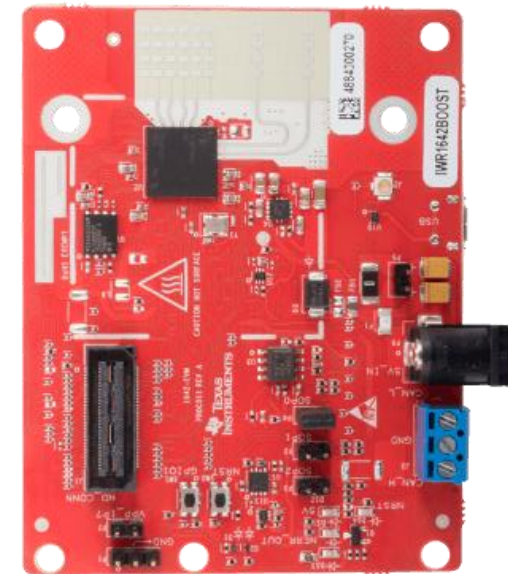
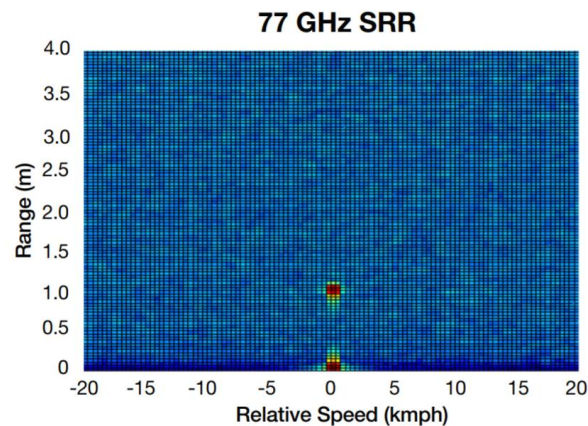
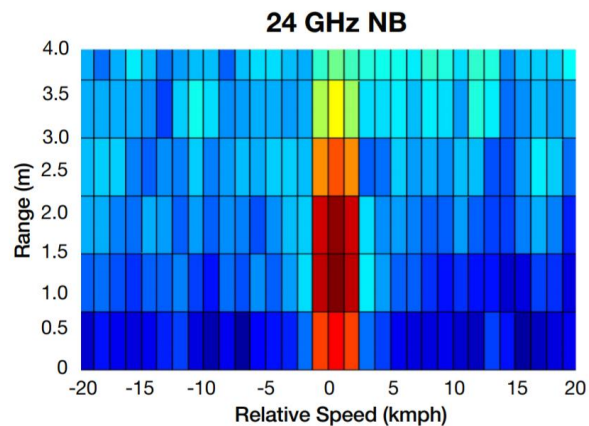
IWR1642BOOST PARAMETERS

- FOV 30x70deg
- Speed accuracy less than 0.1kph
- Range accuracy less than 1mm
- Angle accuracy about 1deg
- Angle resolution 15deg (2TX, 4RX antennas)
- Power consumption 2W (2TX, 4RX, 50% duty)
- Transmitted power about 12mW

CONCLUSIONS

- SOTA 77GHz radar sensor
- 3rd party modules manufacturers
- Very fine range measurement ($< 1\text{mm}$)
- Variable antenna design
- mmWave SDK (Code Composer Studio)
- Power consumption less than 3W (DEV kit)
- Possibility to hide sensor

THANK YOU FOR YOUR ATTENTION



LASER, MULTISPECTRAL AND HYPERSPECTRAL SCANNING

Ing. Marko Paško ¹

¹ Expert_for_3D_Landscape, spol. s r.o., Slovakia, www.x3d.sk

Abstract

In this presentation we will discuss similarities in laser, multispectral and hyperspectral scanning. There are also differences, which are unique for each type of data acquisition and can be used with advantage. We described possibility of combined usage of mentioned measuring sensors, which rise the added value of results and is suitable for scientific analyses, with highest geometrical and georeferencing accuracy.

Data fusion from terrestrial, mobile and aerial 3D mapping enables complete coverage of complex objects. As during data processing will be created a big datasets, we provide also solutions for further data processing and data fusion.

Key words:

- Laser, multispectral and hyperspectral scanning
- Riegl LMS - airborne, mobile, UAS and terrestrial laser scanning and mapping systems
- Vexcel Imaging - airborne, mobile and terrestrial digital photogrammetry and mapping systems
- HySpex - field/outdoor, lab, aerial and industrial hyperspectral scanning in VNIR and SWIR spectral bands
- 3D mapping and data acquisition
- advantage of combination / data fusion from multiple sources,
- outputs from complex mapping systems,
- detailed high density data
- processing software

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3D MEASUREMENT AND IMAGING

*MODERN CONTACTLESS MEASUREMENTS
IN INDUSTRIAL PRACTICE*

**LASER,
MULTISPECTRAL AND
HYPER SPECTRAL SCANNING**

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

LASEROVÉ, MULTISPEKTRÁLNE A HYPERSPEKTRÁLNE SKENOVANIE

Novinky z pohľadu

Expert_for_3D_Landscape, spol. s r.o., www.x3d.sk

autorizovaného distribútora nasledovných značiek pre Slovensko:

Digitálna
fotogrametria



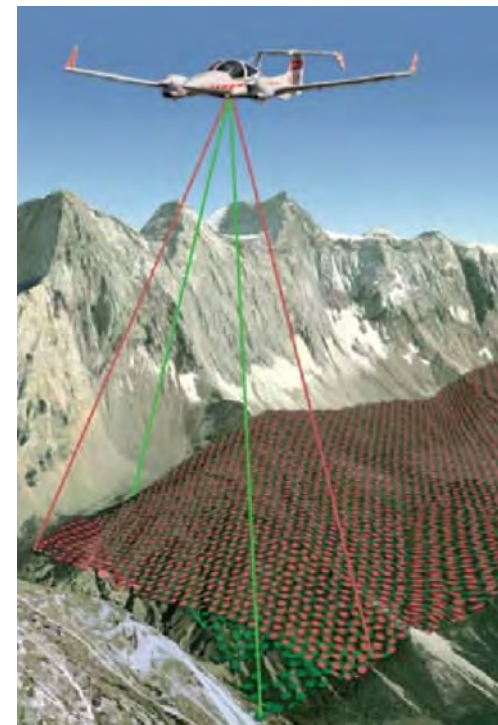
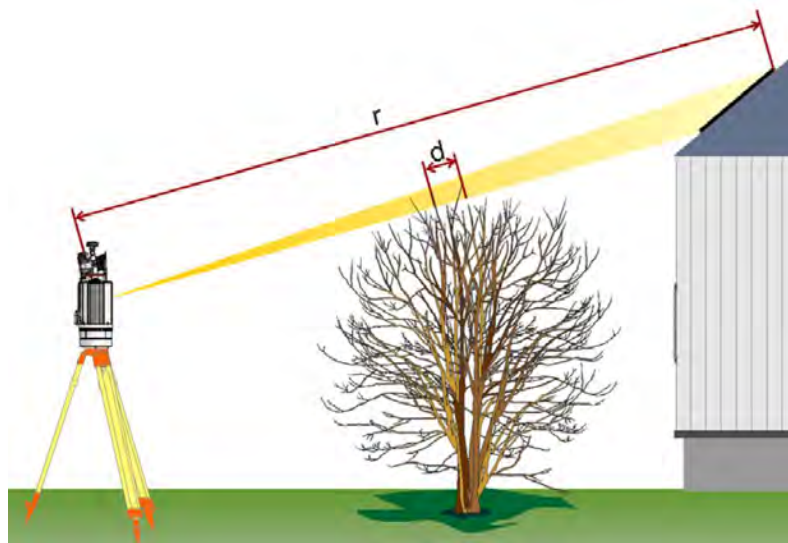
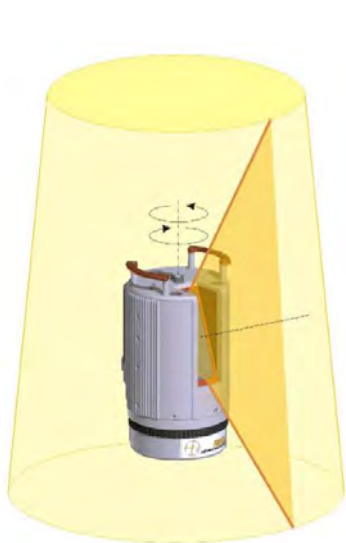
Laserové
skenovanie



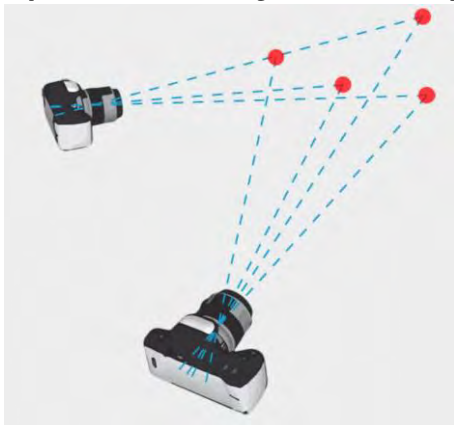
Hyperspektrálne
skenovanie



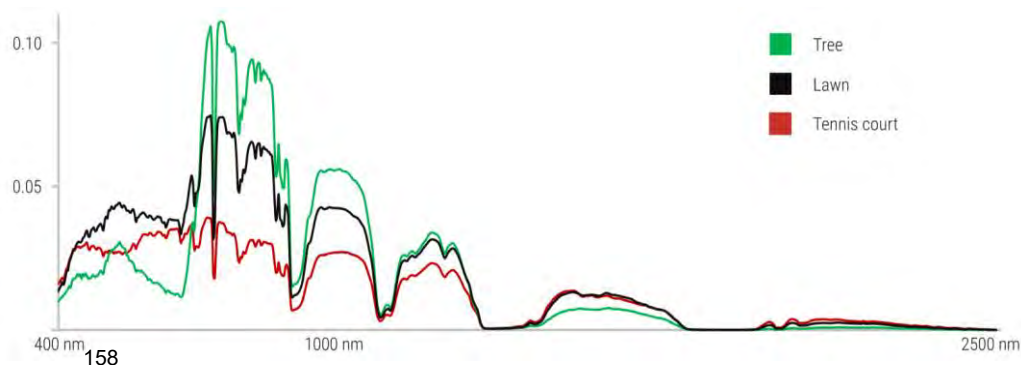
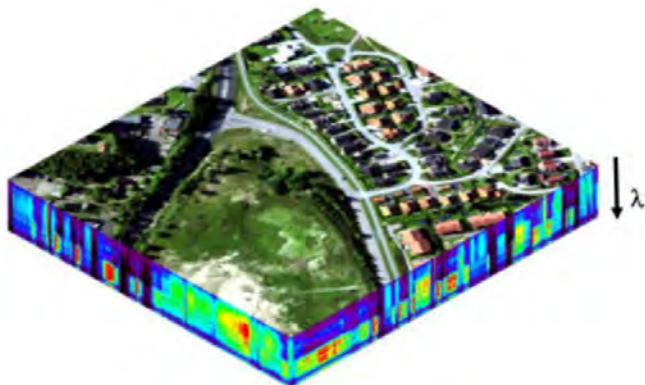
Laserové skenovanie – laserový skener aktívne vysiela z daného miesta daným smerom modulovaný signál s vlnovou dĺžkou blízkeho infračerveného spektra (príp. zeleného svetla) a zachytáva vrátený signál, toto mnohokrát za sekundu opakuje, čím postupne meria v 3D **bod po bode** okolitý priestor



Multispektrálne skenovanie – vychádzajúc z digitálnej fotogrametrie : pasívne zaznamenávanie viditeľného elektromagnetického žiarenia a meranie na digitálnych snímkach, pričom štandardná farebná digitálna snímka je multispektrálny záznam v 3 kanáloch R,G,B. Ak automatizovane zaznamenávame digitálne snímky s vysokým prekrytom -> môžeme využiť automatickú relatívnu orientáciu – prehľadávanie snímky po snímke, **pixel po pixli** hľadáme identické body. Keď ich nájdeme, pretínaním spojnice bodu na snímke a optického centra príslušnej snímky dostaneme bod v 3D.



Hyperspektrálne skenovanie – hyperspektrálny skener zaznamenáva z daného miesta s danou šírkou záberu pre každý pixel prijatý signál po kanáloch, pričom pre každý kanál je vyhranený presne definovaný malý rozsah vlnových dĺžok spektra elektromagnetického žiarenia od viditeľného do stredného infračerveného pásma, toto mnohokrát za sekundu opakuje a postupne sa posúva určitým smerom, čím postupne zaznamenáva pixel po pixli toľko dátových vrstiev, koľko má kanálov. Pokiaľ ide o reálny záznam krajiny, georeferencovaný výsledok vyžaduje poskytnutie informácie o 3D povrchu, na ktorý sa daný hyperspektrálny záznam prekresľuje, napr. z laserového skenera.



Riešenia RIEGL Laser Measurement Systems



- * **Terestrické:** - [VZ-400i](#) ... dosah 800m, presnosť 5mm, georeferencovanie v reálnom čase, cloud
- [VZ-2000i](#) ... dosah 2500m, presnosť 5-10mm
- * **Mobilné:** - [VMX-1HA/2HA](#) ... mobilné presné skenovanie,
- [VMQ-1HA](#) ... light-verzia s 1 skenovacou hlavou

* **Letecké + UAV:**

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



Riešenia Vexcel Imaging



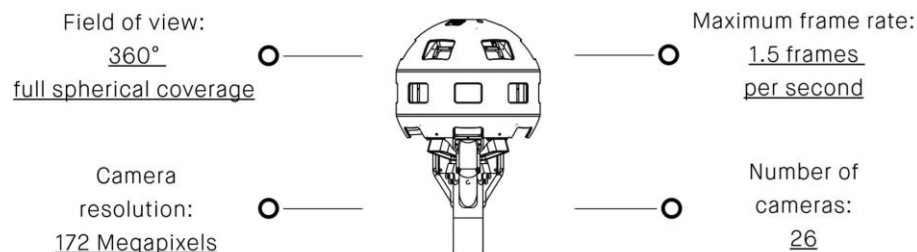
- fotogrametrické technológie na 3D mapovanie
- **Letecké riešenia**
 - Flexibilné – vymeniteľné objektívy [UC Eagle Mark 3](#),
najväčšia šírka záberu 26460 px
 - Šikmé snímkovanie – [UC Osprey Mark 3 Premium](#) -
 - Konkurencia satelitným senzorom – [UC Condor Mark1](#)
- **Mobilné riešenia:**
 - [UltraCam Mustang](#) – mobilný zber dát autom
- **Pochôdzne riešenia:**
 - [UltraCam Panther](#) – zber dát pešo človekom
- Jedno softvérové prostredie [UltraMap](#)



Riešenia Vexcel Imaging



PANORAMIC HEAD



CAMERA

Imaging sensor	CMOS
Sensor size	3,088 x 2,152 pixels
Pixel pitch	1.4 x 1.4 µm
Color filtering type	Bayer Pattern
Focus type	Fixed focus
Focal length	3.24 mm
F-number	2.00
Depth of field	1.5 m to infinity
Optical format	1/3.6 inch

Riešenia Vexcel Imaging



COMPUTER AND DATA STORAGE

Type:
Industrial PC Core i7
USB3 & Ethernet
interface available

Storage capacity:
4 TB SSD
hot-swappable

Interface:
Ruggedized
tablet PC

BATTERY SYSTEM

Type:
V-Mount Li-Ion high
load battery 14.4 V

Operating time at continuous
data capture:
Several hours
depending on application

Capacities & weight:
294 Wh, 1.4 kg
155 Wh, 1.0 kg
89 Wh, 0.8 kg

Riešenia Vexcel Imaging



MODULES

Orientation	Applanix APX-15L
Odometry	Stereo camera system for indoor localization and enhanced outdoor localization in dense cities and covered areas
LIDAR	Velodyne VLP-16

ACCURACY

Relative accuracy (outdoor and indoor)	cm range*
Absolute accuracy (outdoor)	cm to dm range*
Absolute accuracy (indoor)	Accuracy depends on scene structure, loop closures and track length

*Accuracy depends on location and user compliance with walking regulations based on application area.

APPLICATION AREAS

DOCUMENT

Visual Documentation & Exploration

- Mobile mapping
- Disaster response
- Progress documentation
- Risk analysis
- Quality control
- Damage inspection

EXTRACT

Feature Extraction & Classification

- Forest management
- Topographic mapping
- Object detection
- Asset inventory

MODEL

Feature Measurement & Reconstruction

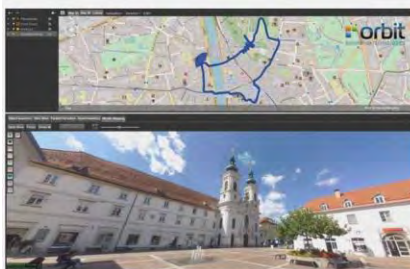
- Clearance measurements
- Volumetric analysis
- As-built verification

Riešenia Vexcel Imaging



DATA FORMATS

Image	JPEG, TIFF
	Camera images (26 x 6.6 Megapixels)
	360° x 180° equi-rectangular panorama (1 x 105 Megapixels) Cube-face panorama (6 x 16.7 Megapixels)
Trajectory	Various formats - position and orientation for each cube
Point cloud	Laser File Format (LAS) - coordinates, reflectivity, color images

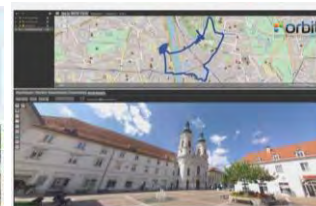


Riešenia Vexcel Imaging



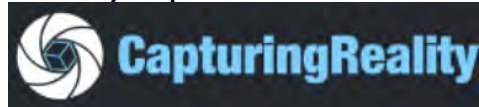
Spracovanie dát z mobilného zberu dát z UltraCam Mustang a UltraCam Panther Mark2:

- Jedno prostredie – **UltraMap Terrestrial v1.1**
- Produkty:
 - **rektifikované (neskreslené) meračské snímky na presné fotogrametrické merania**
 - **georeferencované mračná bodov laserového skenovania v tvare las**
 - **kvalitné obrazové panorámy**
- Priamy výstup do softvérového prostredia **OrbitGT 3DM**, prepojenie s dátami z Riegl LMS



- Štandardný výstup Default použiteľný v softvéroch:

RealityCapture



Euclidean Geoverse Complete



PhotoModeler Premium



Riešenia HySpex

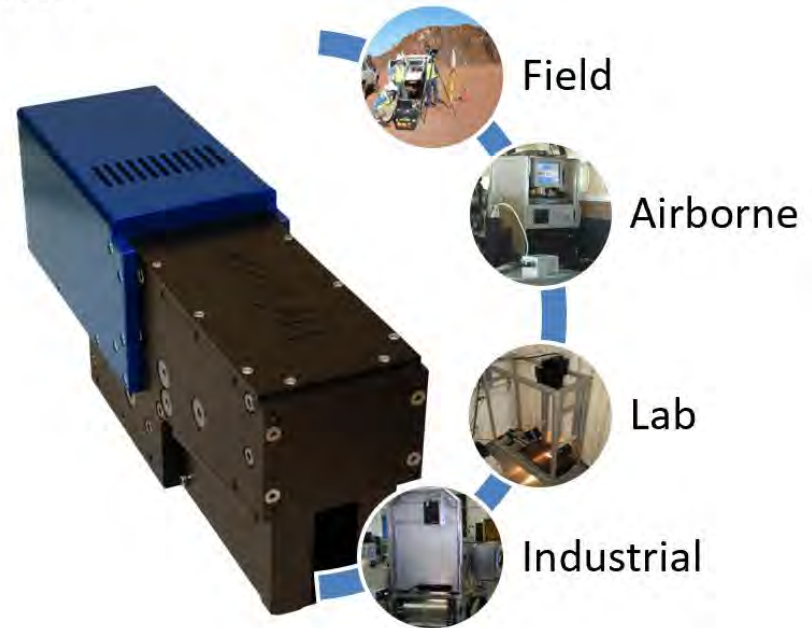
HySpex

Hyperspectral imaging systems for all applications

The same instrument can be used for:

- Lab measurements
- Field/outdoor scanning
- Airborne Applications
- Industrial applications

Thus making it a very versatile instrument.



Riešenia HySpex



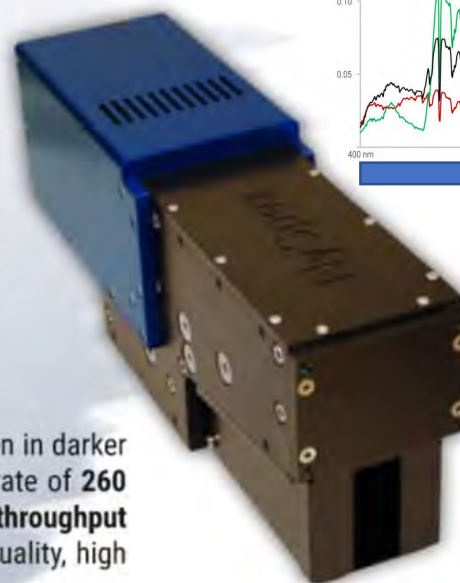
HySpex VNIR-1800

The HySpex VNIR-1800 **hyperspectral camera**, is developed for **field, laboratory, airborne** and **industrial** applications.

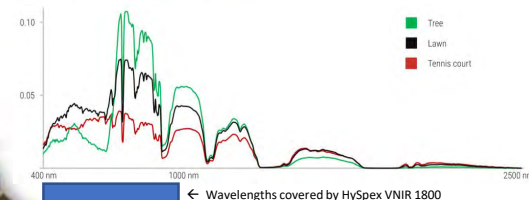
HySpex VNIR-1800 utilize a cutting edge **actively cooled and stabilized scientific CMOS** detector. This makes VNIR-1800 the ideal camera for high-end data acquisitions where **high radiometric accuracy** is required.

The dynamic range of 20 000 ensures **outstanding SNR levels** even in darker areas of an image of highly dynamic scenes. With a max frame rate of **260 fps**, combined with **aberration corrected optics** and **high optical throughput** (f/2.5), HySpex VNIR-1800 offers a unique combination of data quality, high speed and sensitivity.

A wide range of **close-up lenses** allows the use of the camera at working distances ranging from a few cm with a **spatial resolution of 24 μm** , to infinity for e.g. **airborne remote sensing**.



HySpex VNIR-1800.



Riešenia HySpex

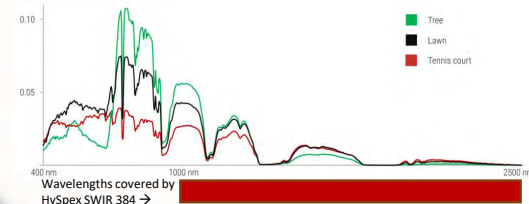
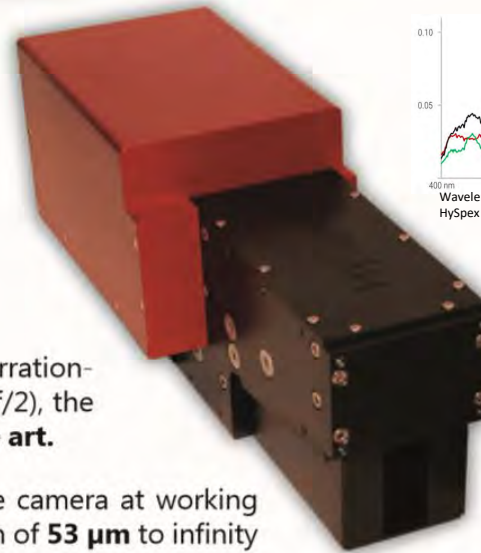


HySpex SWIR-384

The new HySpex SWIR-384 hyperspectral camera from NEO, is developed for **field, laboratory, airborne and industrial applications**. The new state of the art MCT sensor with cooling down to 150K yields low background noise, high dynamic range and **exceptional SNR levels**.

With a max frame rate of **400 fps**, combined with an aberration-corrected optical system with high optical throughput (f/2), the **data quality, speed and sensitivity** is truly **state of the art**.

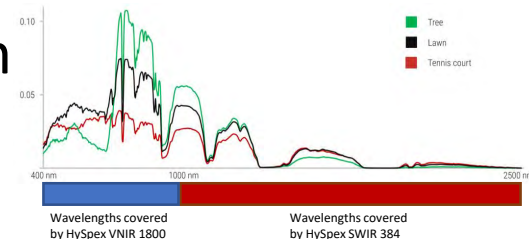
A wide range of **close-up lenses** allows the use of the camera at working distances ranging from a few cm with a spatial resolution of **53 μm** to infinity for e.g. airborne remote sensing.



Riešenia HySpex

Spoločné použitie 2 hláv VNIR-1800 a SWIR-384 naraz:

- široké pokrytie spektra od 400nm do 2500nm

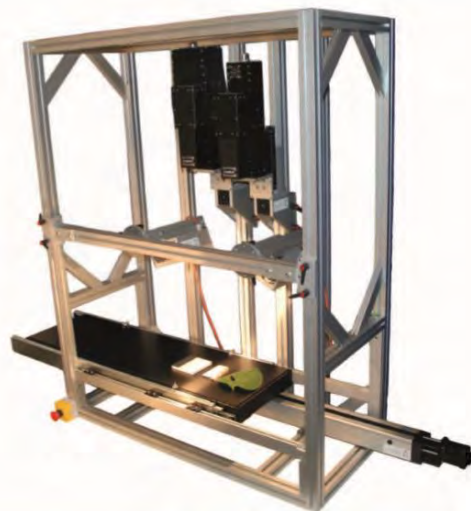


Mnohonásobné využitie

- nasadenie v konfigurácii field, lab aj aerial



Field – poľné



Lab – laboratórne



Aerial - letecké

Riešenia HySpex

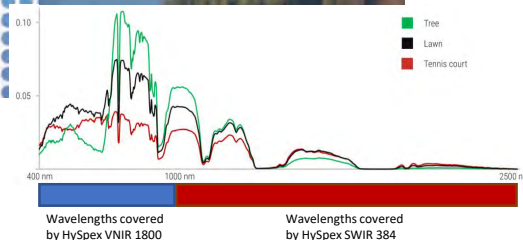


HySpex MJOLNIR-VS-620

Combining HySpex Mjolnir V-1240 and HySpex Mjolnir S-620 into a common housing, HySpex Mjolnir VS-620 provides 620 coregistered pixels in the VNIR and SWIR spectral range, 400 - 2500 nm.

For applications requiring low mass, combined with high performance specifications and scientific grade data quality on the full VNIR-SWIR range, HySpex Mjolnir VS-620 is an ideal solution. In addition to the high quality hyperspectral data cube, covering the spectral range from 400 - 2500 nm, with 490 bands, double resolution data in the VNIR range is always readily available.

With smile and keystone less than 0.1 pixel for each spectral range, the merged Mjolnir VS-620 data product will have co- registration/keystone better than 0.2 pixel for the full VNIR-SWIR range. Mjolnir VS-620 is delivered in a rugged bundle with a high end data acquisition unit and normally also with the Trimble Applanix APX-15 IMU/GPS.



Zhrnutie

Laserové, multispektrálne a hyperspektrálne skenovanie má veľa spoločného. To, čo ich odlišuje, ich robí jedinečnými zdrojmi dát.

Spoločné využívanie senzorov v rôznych kombináciách zvyšuje pridanú hodnotu výsledku.

Kombinované spracovanie dát zo zeme, z auta a z leteckého nosiča umožňuje kompletné zameranie aj priestorovo členitých objektov.

Ďakujem za pozornosť. Viac na www.x3d.sk



3D IN RADAR METEOROLOGY

RNDr. Vladimír Jorík ¹

¹ SWORAD s. r. o.

Abstract

Throughout the history of radar meteorology, measurements are made in horizontal areas with large elevation steps and the measured values are degraded to the area, or measurements are made in vertical areas, and the gaps in the elevation steps are counted.

SkySCANner – our meteorological radar - provides such a measurement technology that captures the real values at each point of the measured volume during the measurement and records the data into the spatial data structure. These data provide new insights into the structure of the clouds and lead to new knowledge about processes in them.

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3D MEASUREMENT AND IMAGING

*MODERN CONTACTLESS MEASUREMENTS
IN INDUSTRIAL PRACTICE*

3D in radar meteorology

other meteorological radar measurement technology

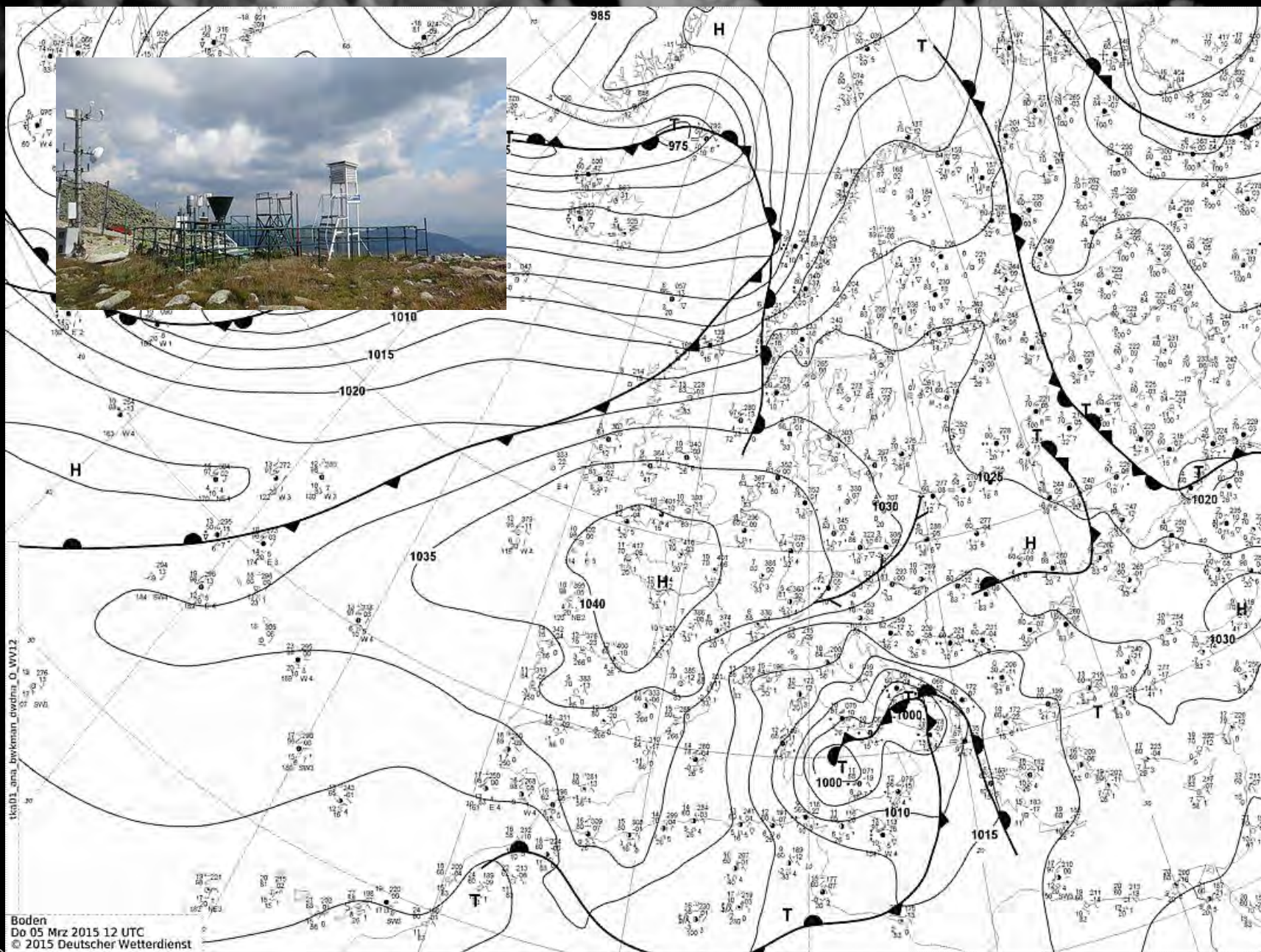
od 0D v meteorológii po 3D v radarovej meteorológii

- ABSTRAKT :
- V celej histórii radarovej meteorológie sa vykonávajú merania v horizontálnych plochách s veľkými elevačnými krokmi a namerané hodnoty sú degradované do plochy alebo sa robia merania vo vertikálnych plochách a medzery v elevačných krokoch sú dopočítavané.
- Naš meteorologický radar skySCANner poskytuje takú technológiu merania, ktorá zachytáva počas merania reálne hodnoty v každom bode meraného objemu a zaznamenáva dáta do priestorovej dátovej štruktúry. Takéto dáta poskytujú nové poznania o štruktúre oblakov a vedú novým k poznatkom o procesoch v nich.

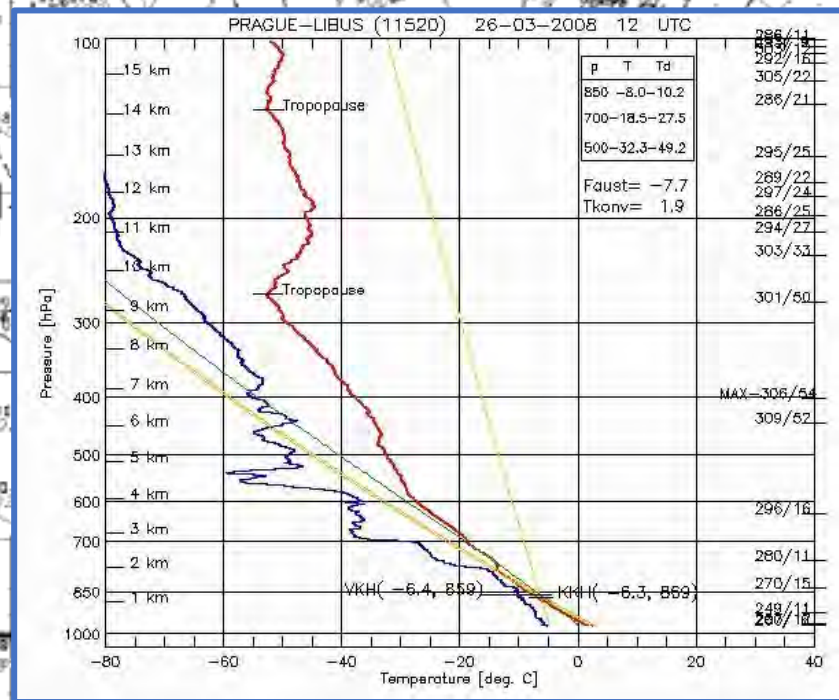
od 0D v meteorológii po 3D v radarovej meteorológii



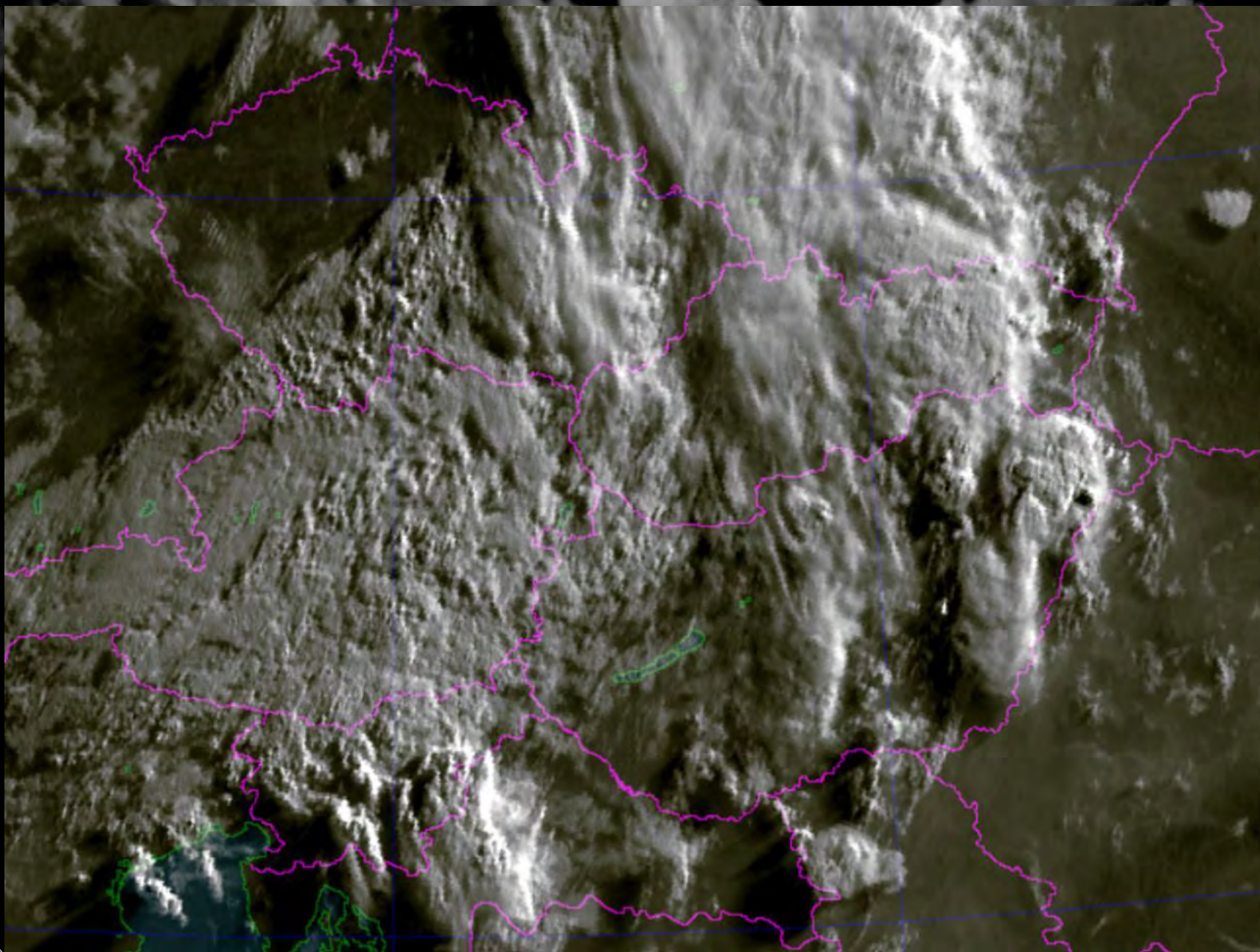
0D : „bodové“ merania synoptických staníc : 2D : prízemná mapa



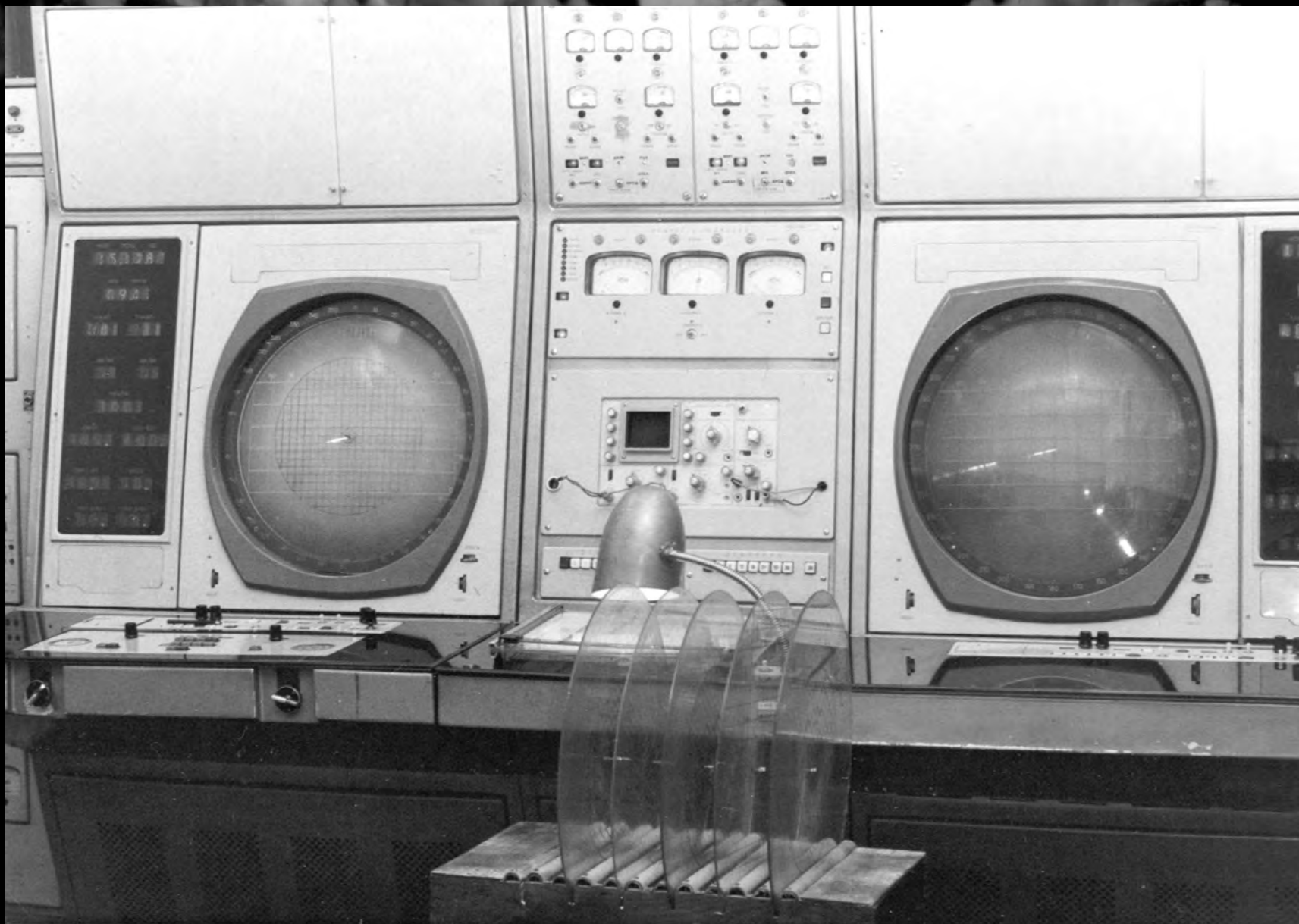
1D : „lineárne“ merania aerologických staníc : 2D : výškové mapy



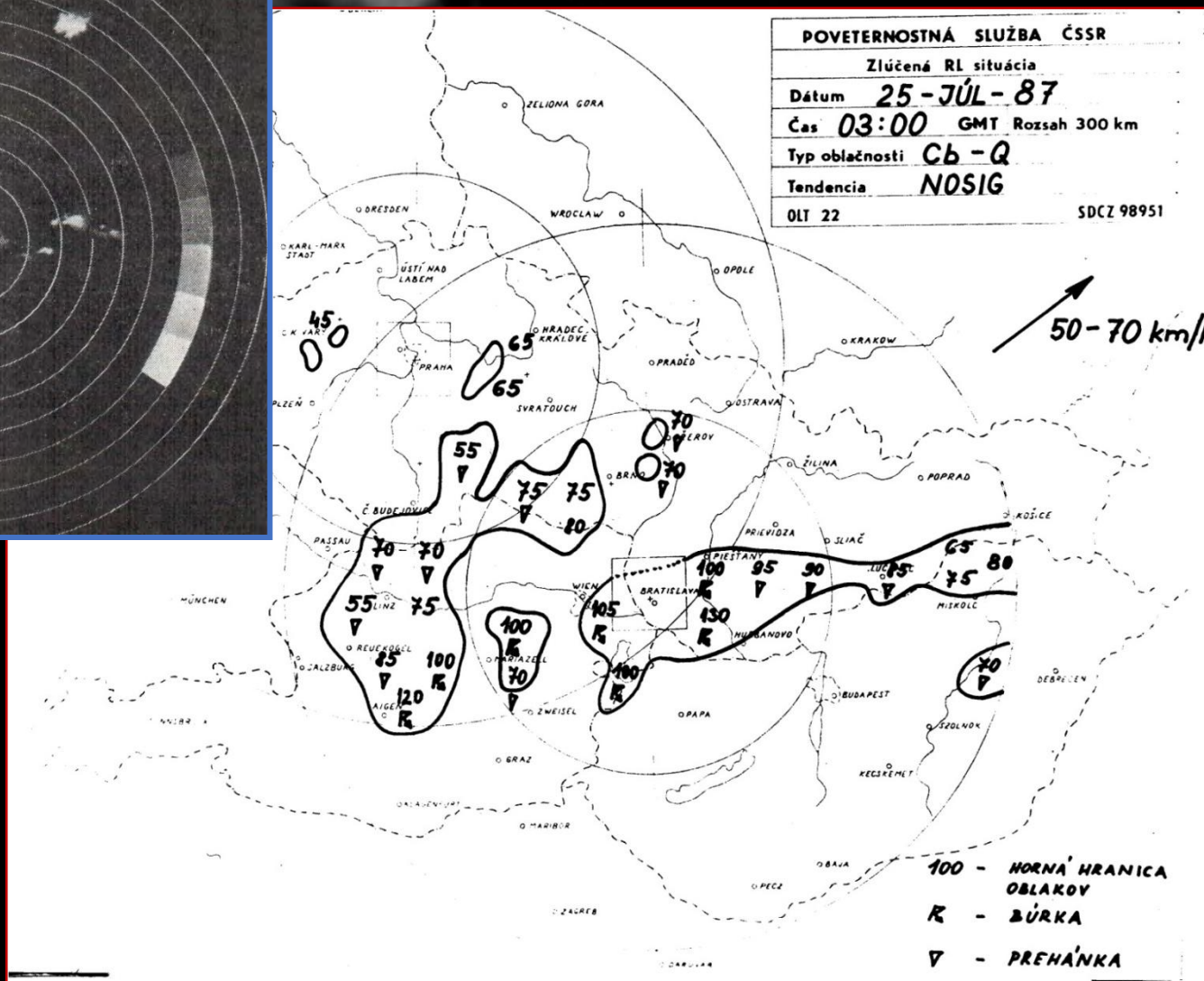
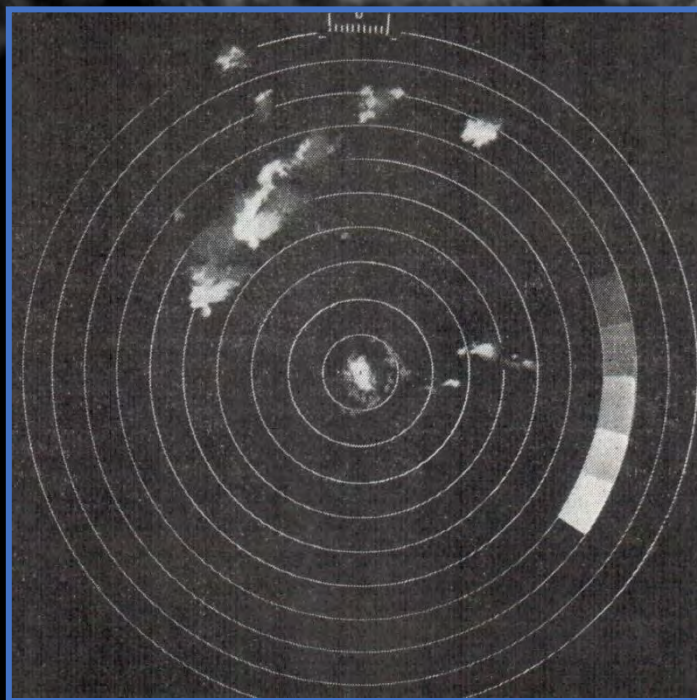
2D : snímanie meteorologickej družice : 2D : snímky



2D : manuálne zakresľovanie radarovej meteorologickej situácie : história



2D : ručné prekresľovanie radarovej meteorologickej situácie : história



kvázi 3D : meranie radarovej meteorologickej situácie : prvé automatizácie

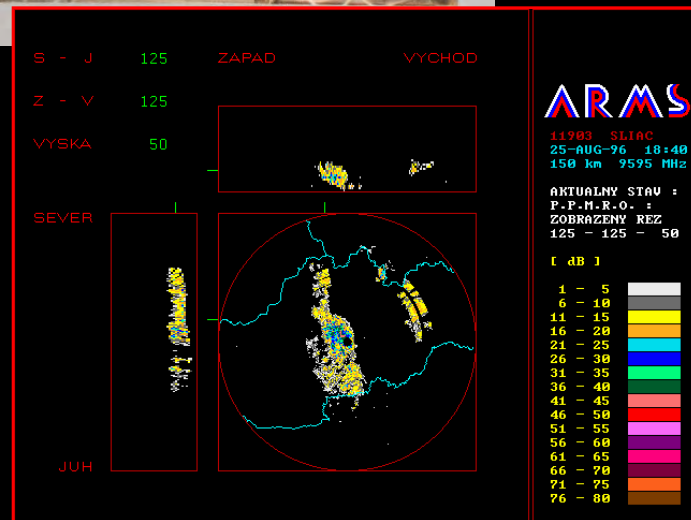
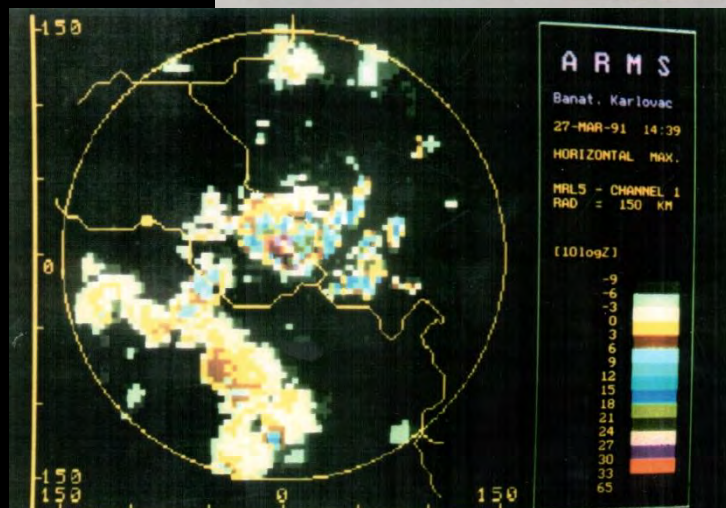
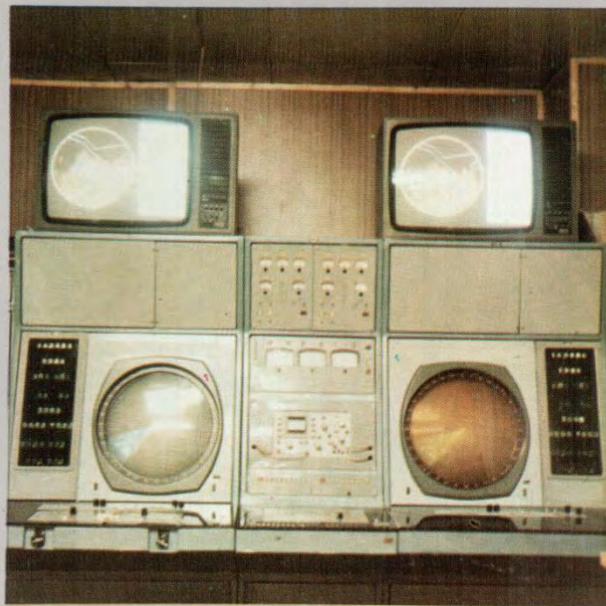
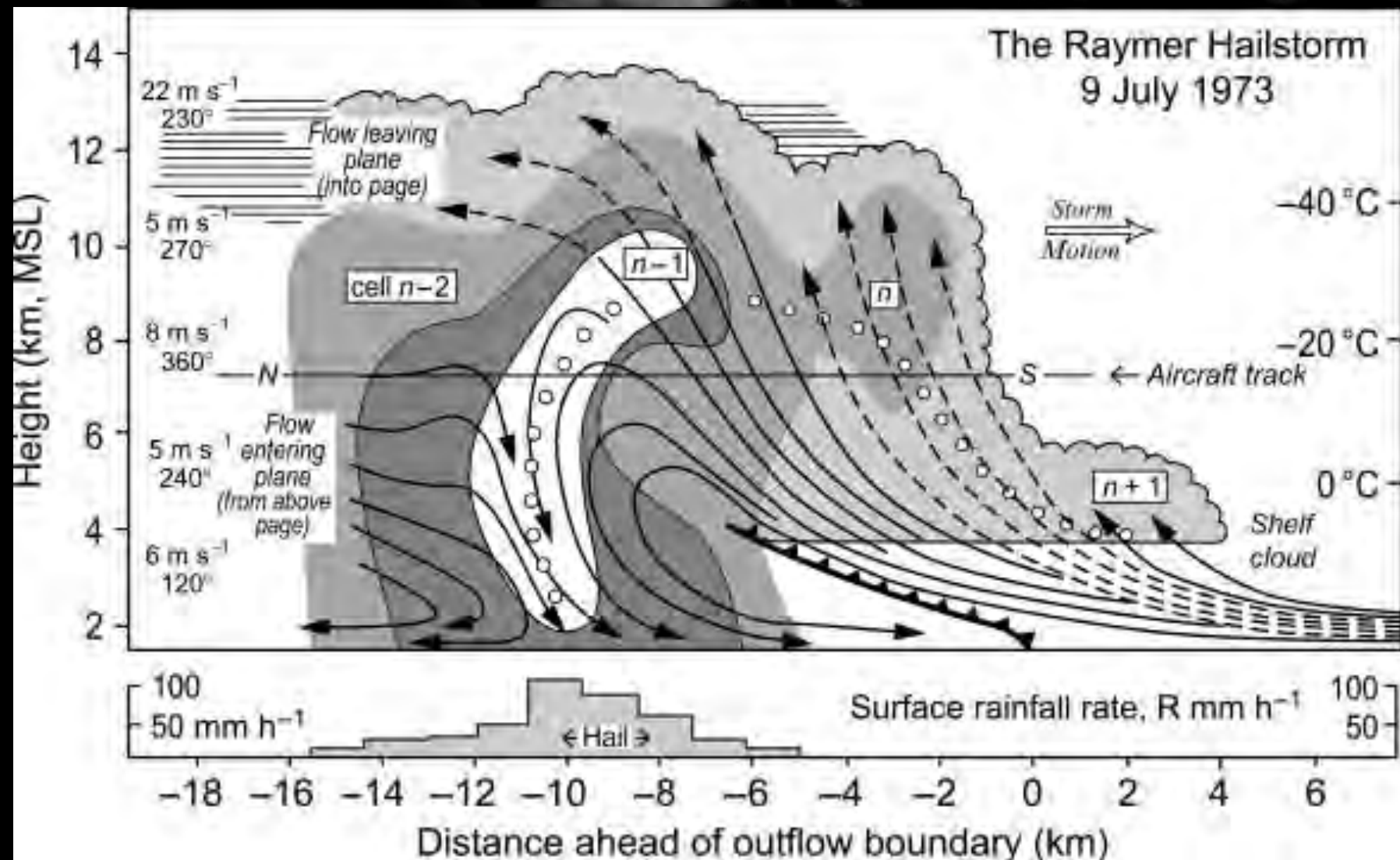


schéma konvektívneho oblaku podľa modelov vychádzajúcich zo spomínaných vstupných dát (0D , 1D , 2D)

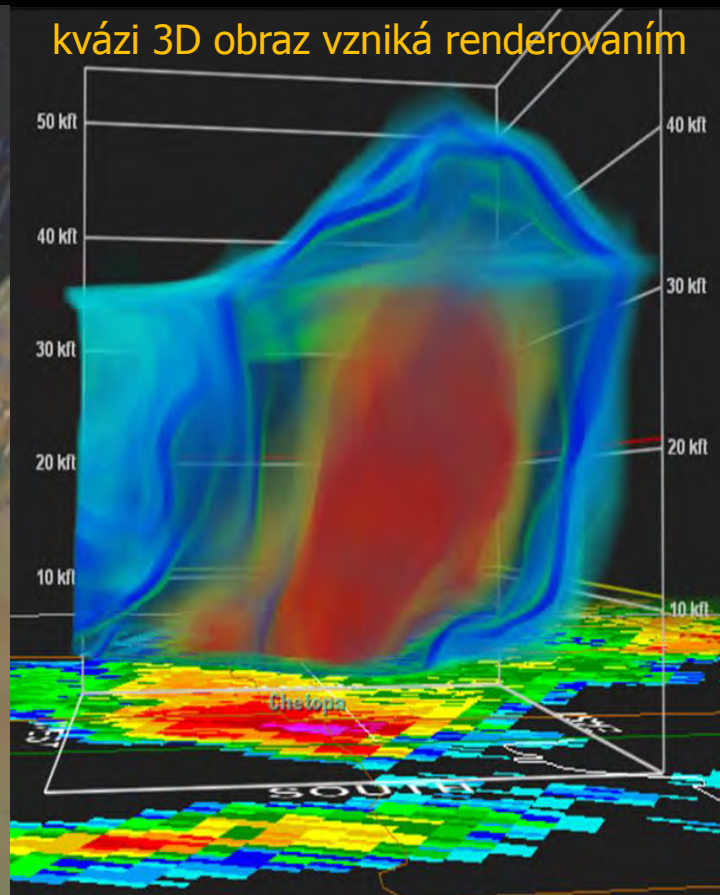


meteorologické radary : ich bežne používaná technológia merania

takto vyzerá technológia merania : trinásť elevačných krokov



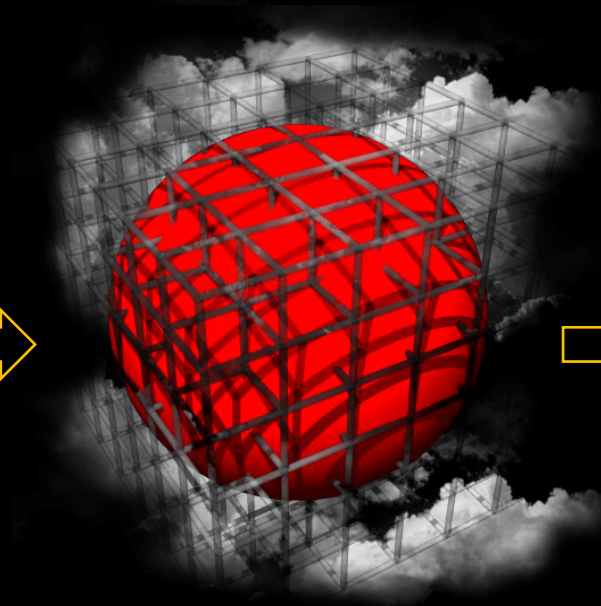
kvázi 3D obraz vzniká renderovaním



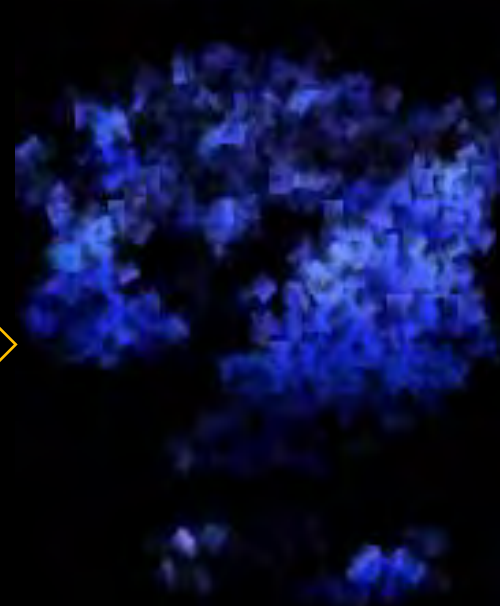
skySCANner podrobná priestorová technológia merania dát



pri meraní sa využíva
elevačná kroková funkcia



dáta sú v reálnom čase odkladané do
priestorovej dátovej štruktúry - PMO

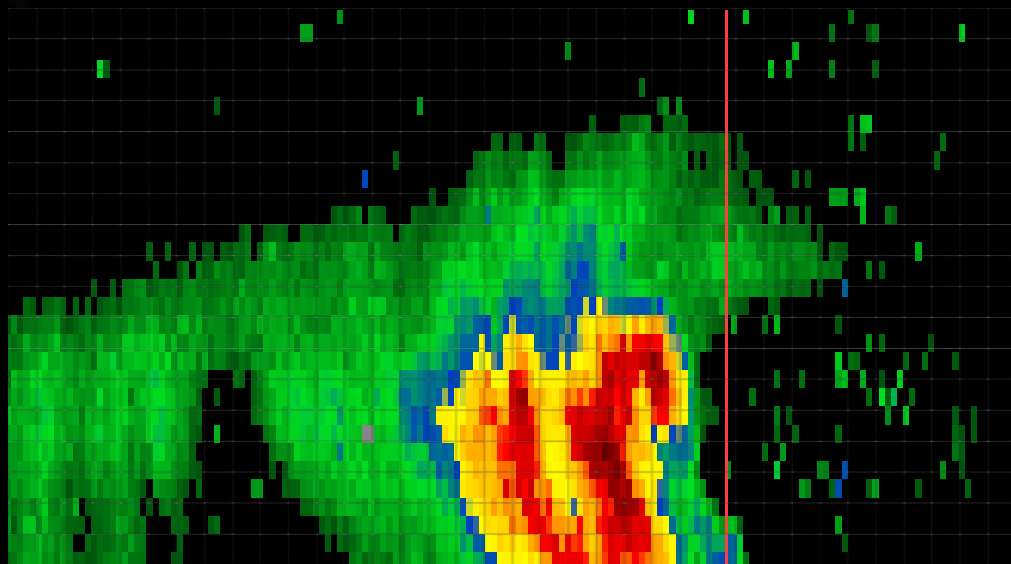


PMO je zmenšená realita,
resp. virtuálny oblak

skySCANner výsledok technológie merania



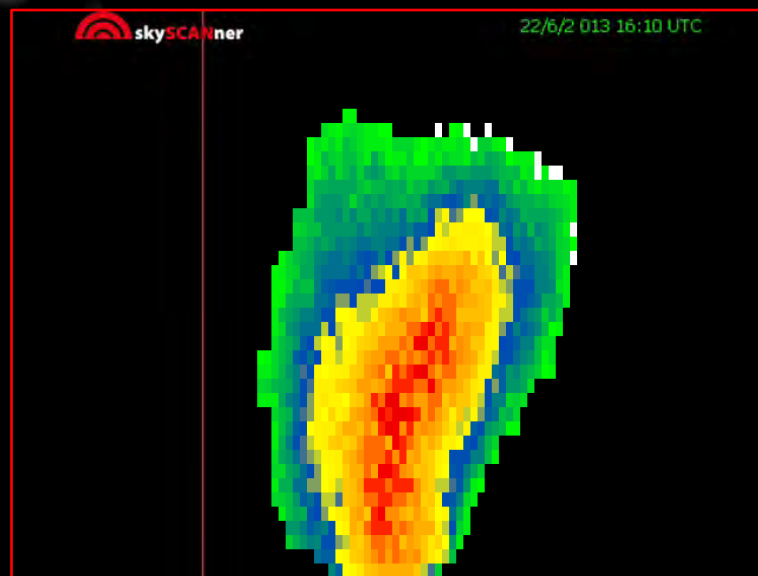
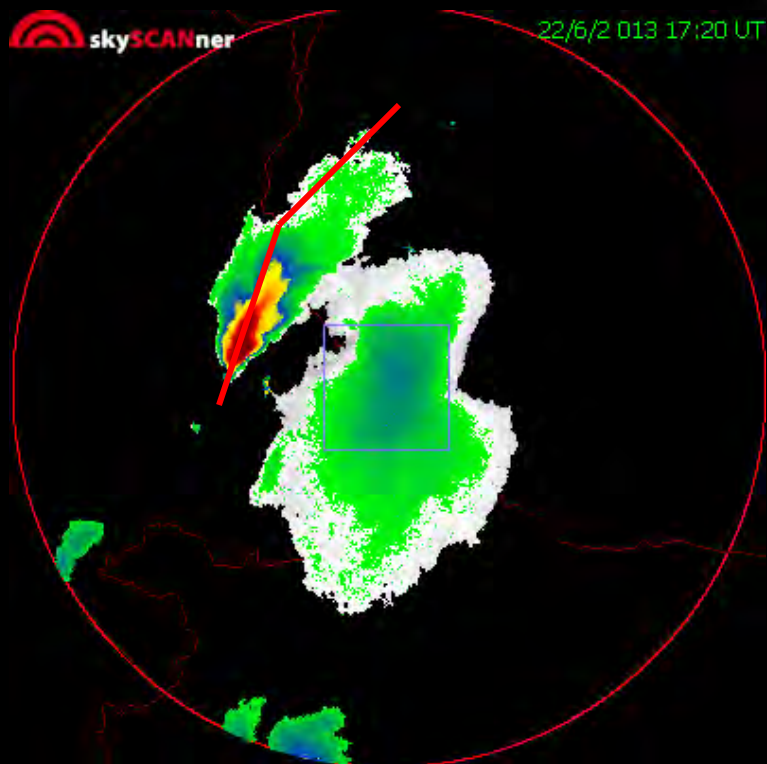
aktuálny Cb (cumulonimbus)
skenovaný do PMO



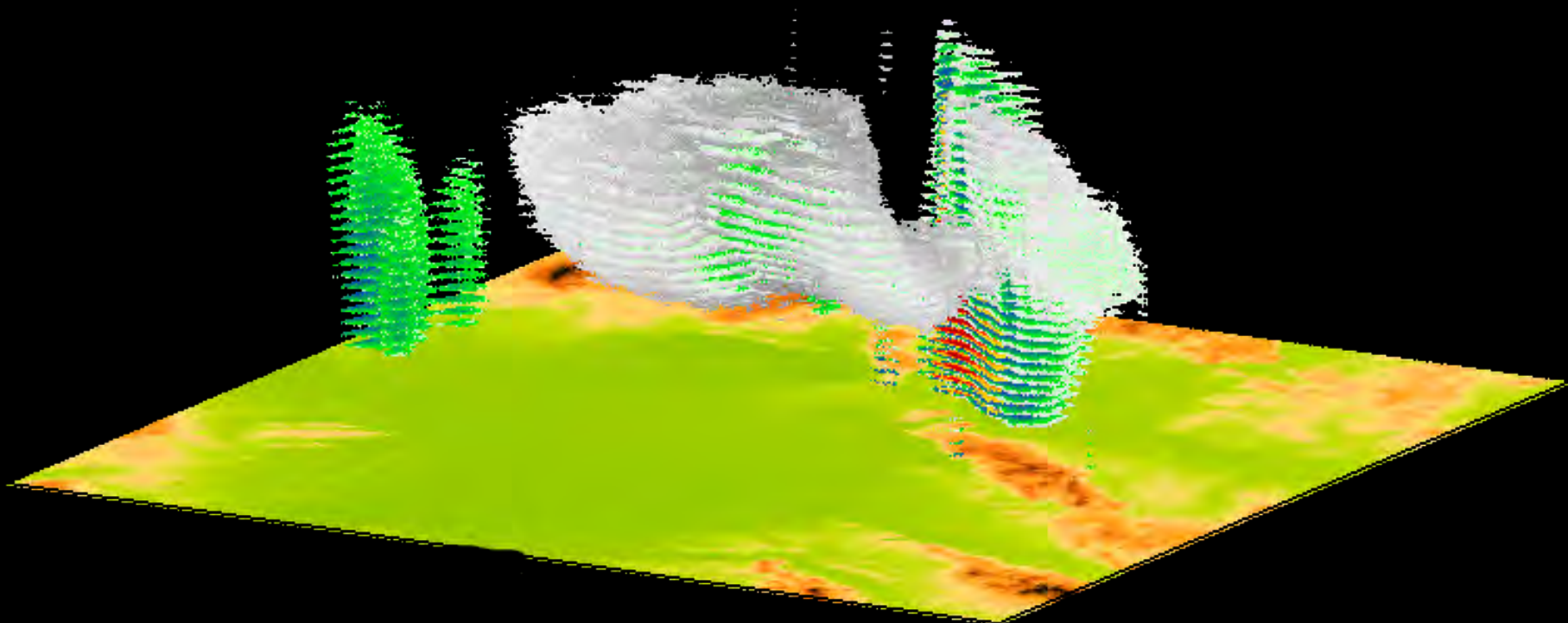
digitálny Cb môže byť zobrazovaný
v každom priestorovom reze
v časovej a priestorovej animácii

skySCANner nameraný a skutočný oblak

porovnanie nameraných dát zo skySCANneru s podobným oblakom po dráhe letu

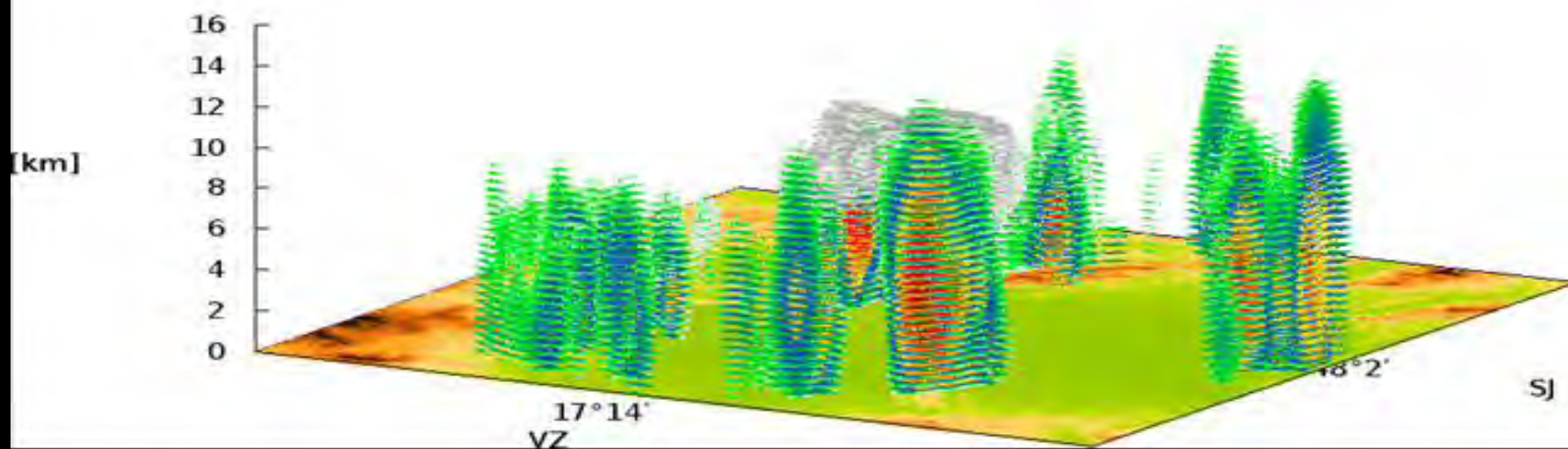


3D skySCANner : výsledok technológie merania



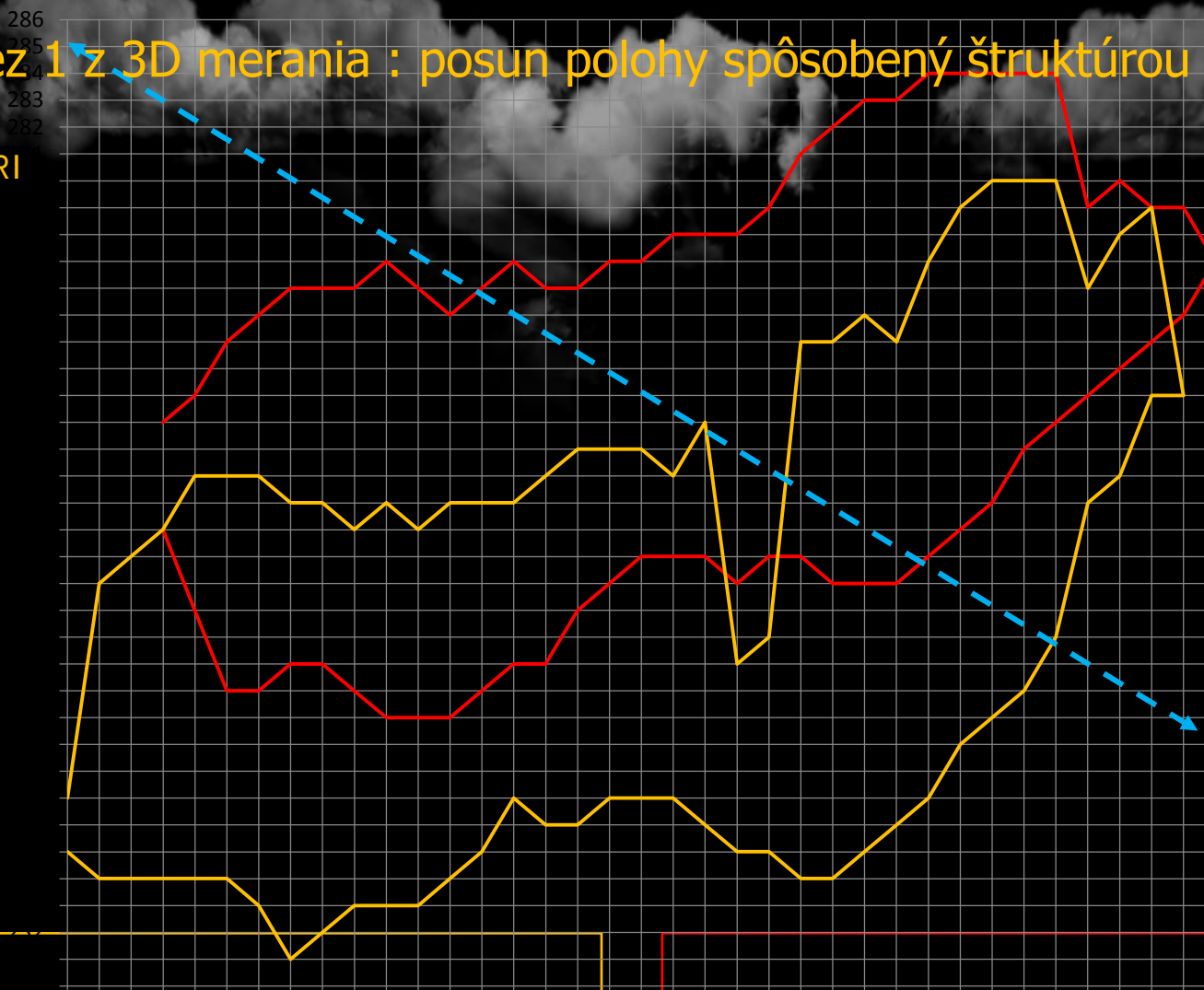
skySCANner : časopriestorová dynamika vývoja konvektívnych oblakov

skySCANner: 15.08.11 17:10 UTC 80 km

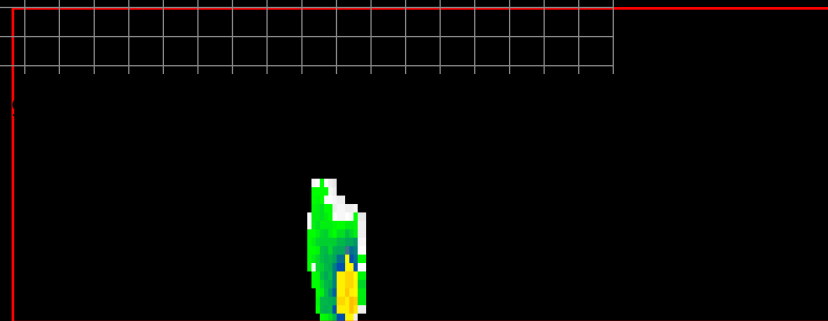
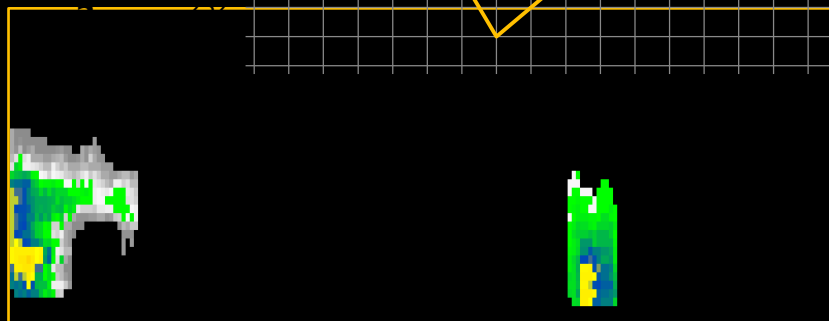


nález 1 z 3D merania : posun polohy spôsobený štruktúrou oblaku

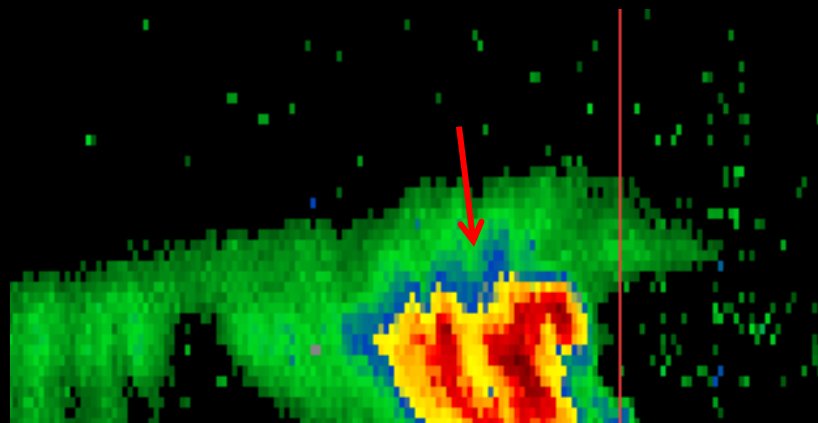
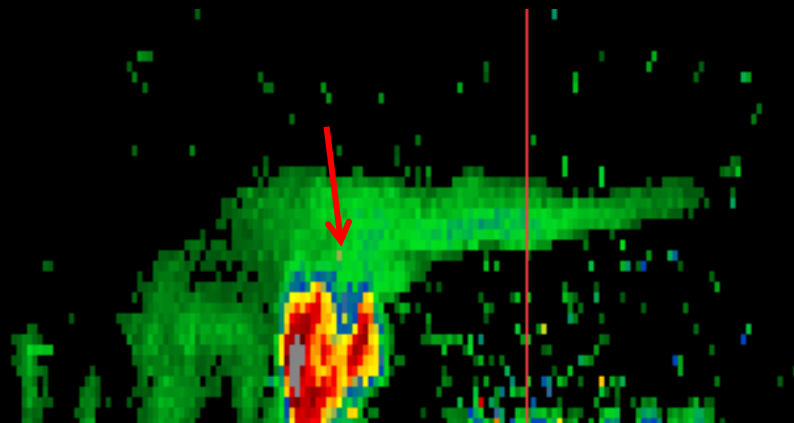
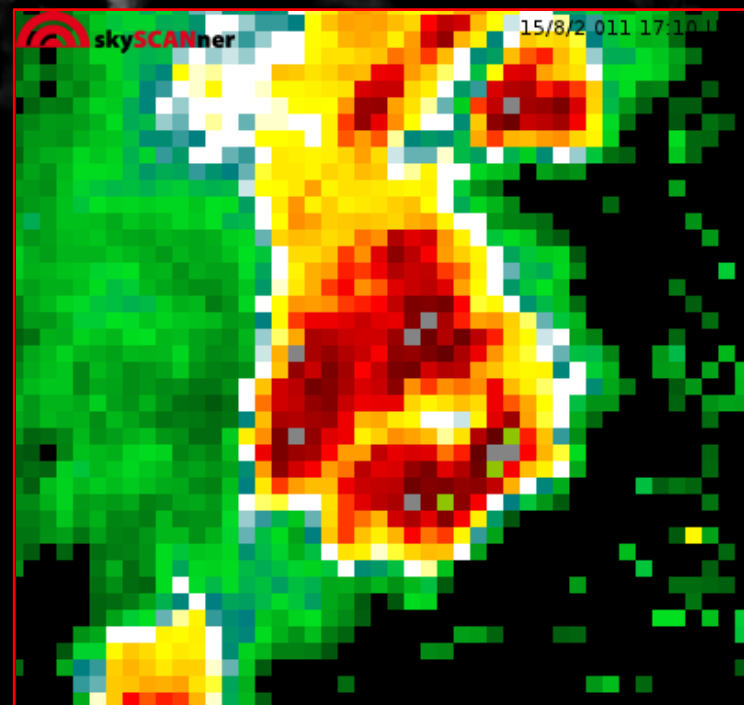
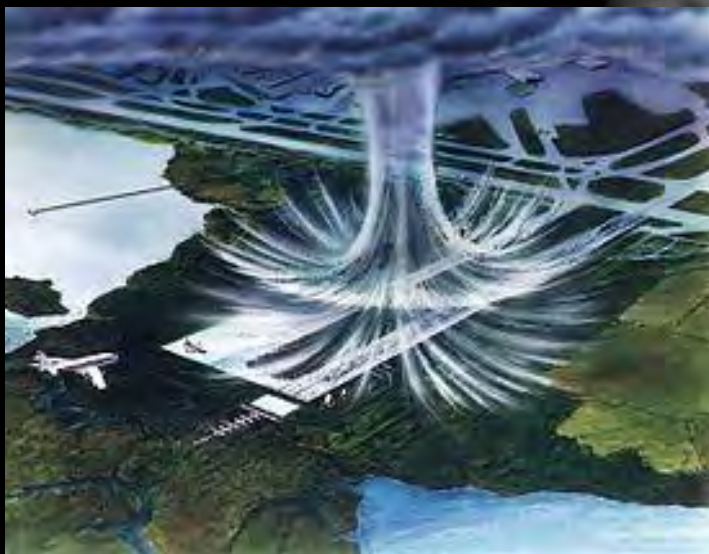
MTRI



HDVC



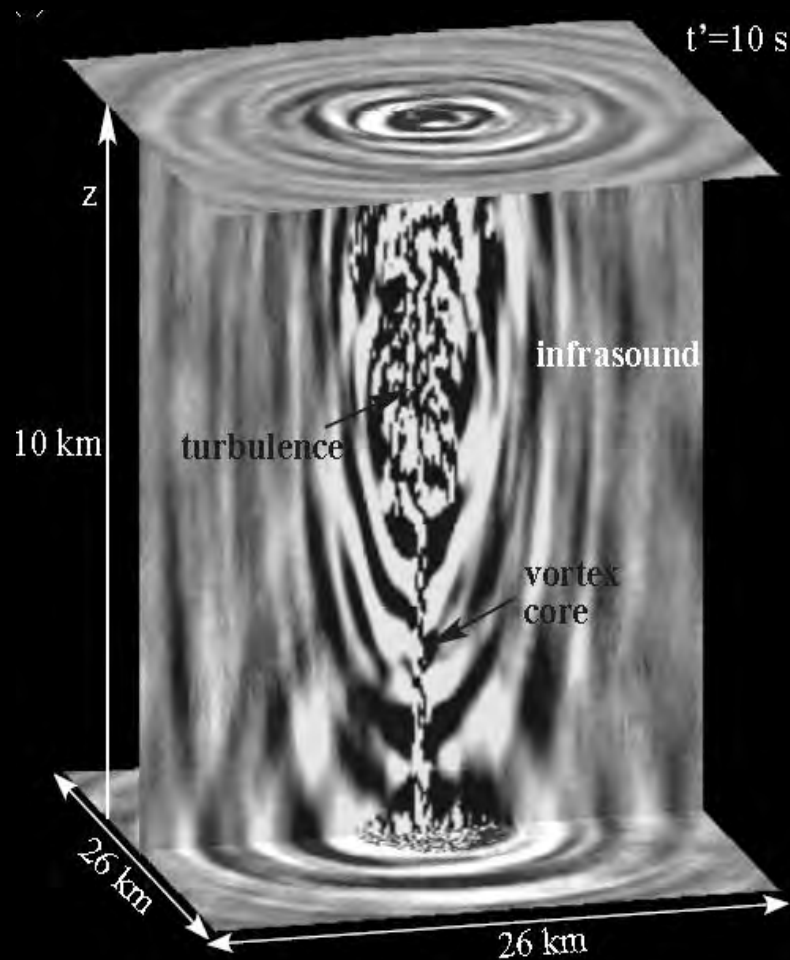
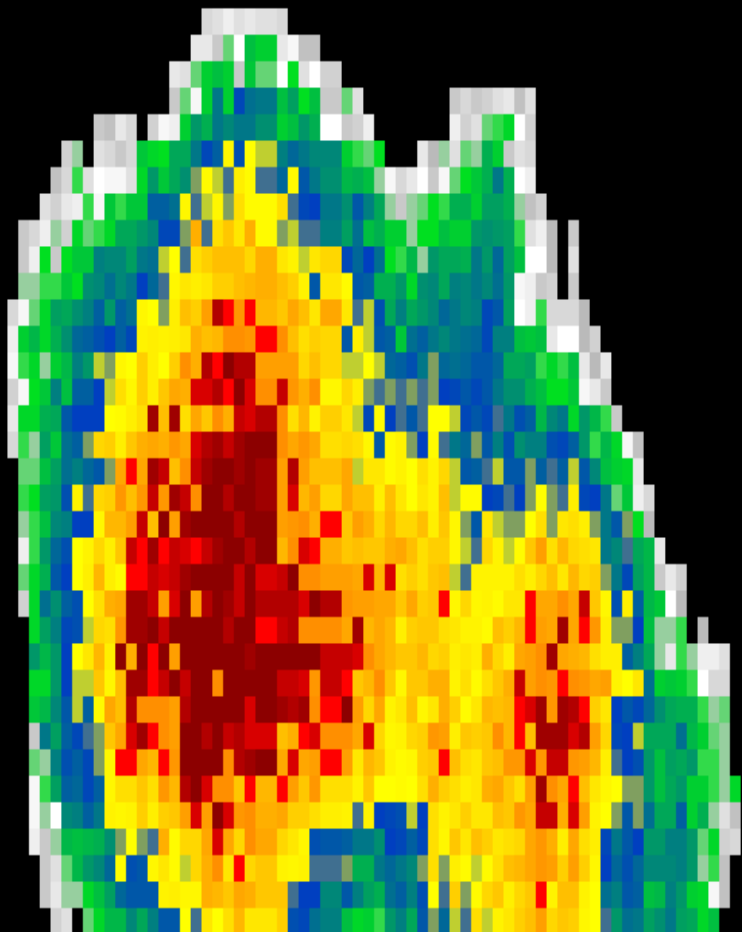
nález 2 z 3D merania : microburst detekovaný meraním skySCANner-u



nález 3 z 3D merania : infrazvuk v konvektívnom oblaku : meranie skySCANnerom a akustický model



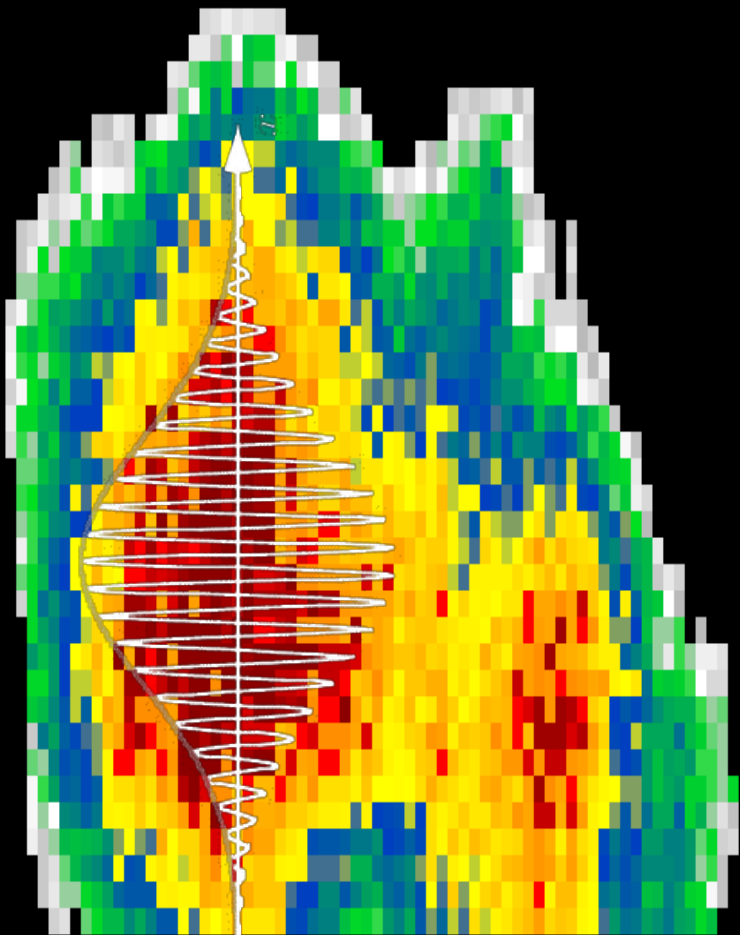
15/8/2 011 17:10 UTC



nález 3 z 3D merania : infrazvuk v konvektívnom oblaku :
podobnosť akustickej štruktúry s oblakom a vplyv akustiky na levitáciu kvapky

skySCANner

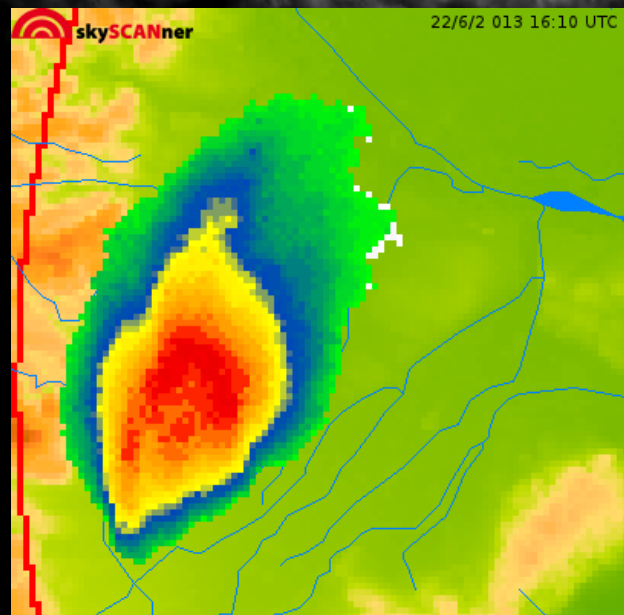
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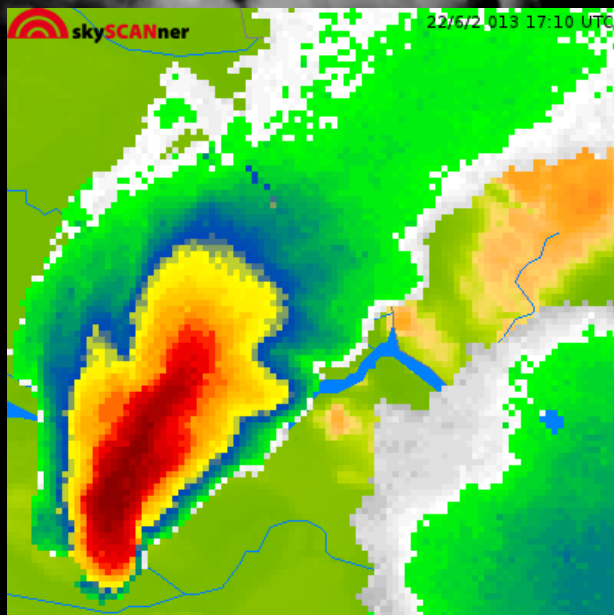
Clemson University

vocativ

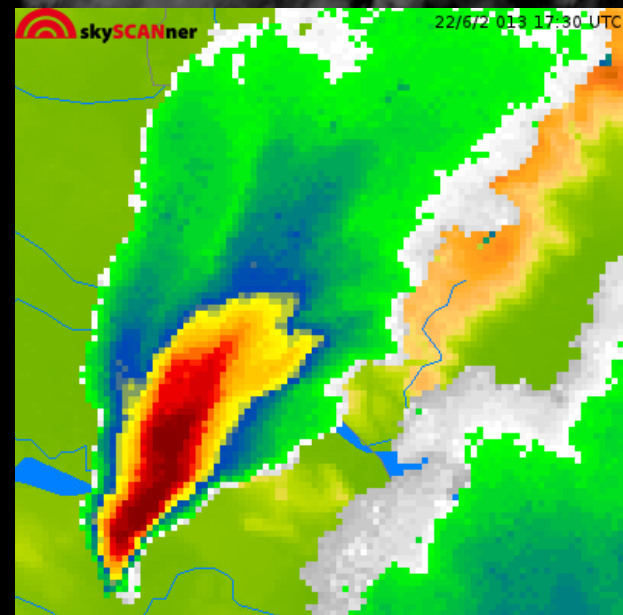
nález 3 z 3D merania : mení infrazvuk štruktúru konvektívneho oblaku ?



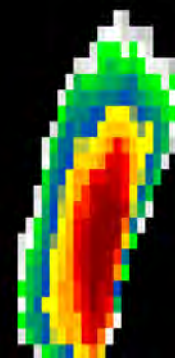
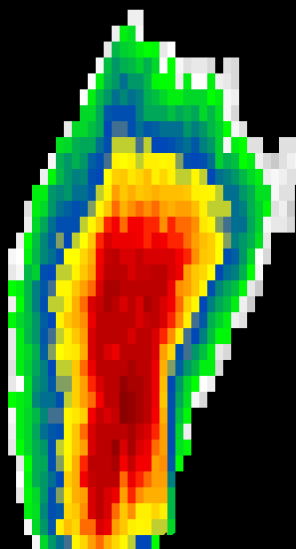
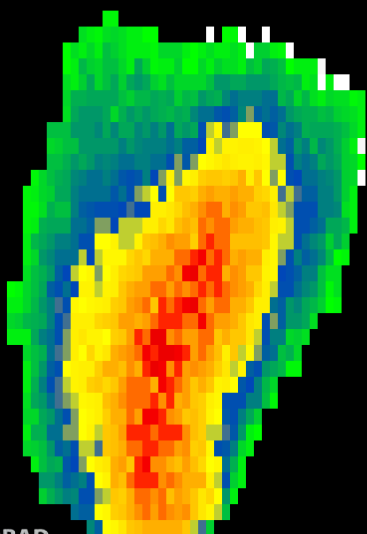
skySCANner 22/6/2 013 16:10 UTC



skySCANner 22/6/2 013 17:10 UTC



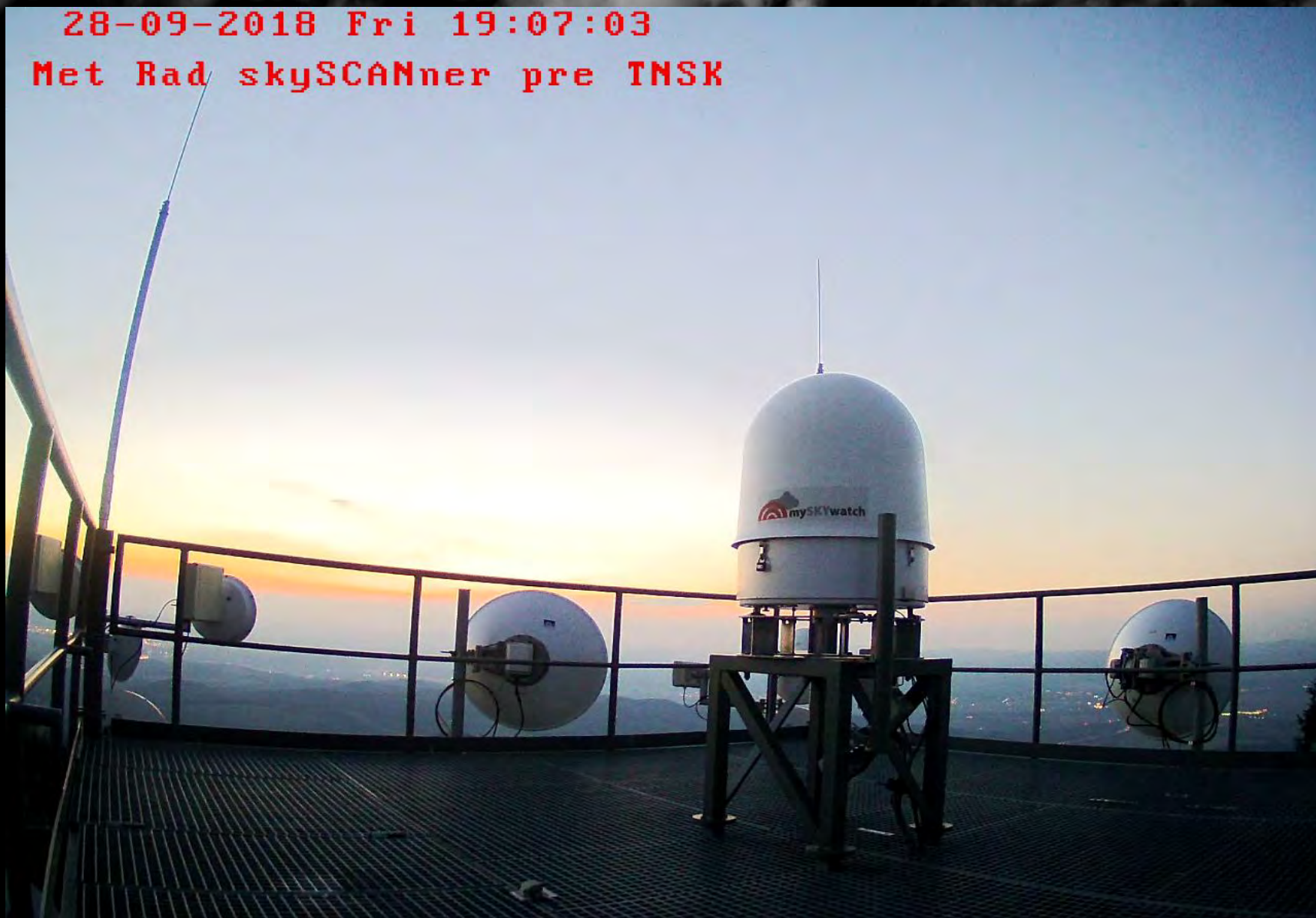
skySCANner 22/6/2 013 17:30 UTC



skySCANner na Meteorologicko Telekomunikačnej Rozhl'adni Inovec

28-09-2018 Fri 19:07:03

Met Rad skySCANner pre TNSK





bez obavy z počasia

04.09 05.09 06.09 07.09 08.09 09.09 10.09 11.09 12.09

149 m.n.m.
130 m.n.m.
0 m.
Zastaviť 09.9.2018, 17.229 N, 48.031 E
Prihlásiť sa

HLAVNÁ STRÁNKA

→ TU ZAČNITE

RADAROVÉ
METEOROLOGICKÉ INFORMÁCIE

O NÁS

FOTKY A VIDEÁ

ČLÁNKY

O SLEDOVANÍ ATMOSFÉRY A
POČASIA

RADARY A SKYSCANNER

O NAŠICH RADAROVÝCH
VÝSTUPOCH

TECHNICKÉ PARAMETRE
SKYSCANNERA

PREČO VÁM INFORMÁCIE
POSKYTUJEME

HLAVŤEVNÁ KNIHA

ODKAZY

KONTAKT

SÚKROMNÝ METEOROLOGICKÝ
RADAR

PRESNÉ A DETAILNÉ MERANIE

VLASTNÉ METEOROLOGICKÉ
ALGORITMY A SOFTVÉR

GRAFICKÁ PREDPOVEĎ
NEBEZPEČNÝCH
METEOROLOGICKÝCH JAVOV
DETEKOVATEĽNÝCH RADAROM

AKTUÁLNE MERANIE

informácie z experimentálnych meraní
poskytujeme verejnosti na našej stránke
www.myskywatch.sk

ION BEAM ANALYSIS AND MODIFICATION OF MATERIALS AT MTF STU

Ing. Pavol Noga, PhD. ¹

¹ Slovak University of Technology in Bratislava

Abstract

An ion beam laboratory for materials research was commissioned recently at the Slovak University of Technology within the University Science Park CAMBO located in Trnava. The facility will support research in the field of materials science, physical engineering and nanotechnology. Ion-beam materials modification as well as ion-beam analysis are covered and deliverable ion energies are in the range from tens of keV up to tens of MeV. Two systems have been put into operation. First, a high current version of the HVEE 6 MV Tandetron electrostatic tandem accelerator with duoplasmatron and cesium sputtering ion sources, equipped with two end-stations: a high-energy ion implantation and IBA end-station which includes RBS, PIXE, ERDA and NRA analytical systems. Second, a 500kV implanter equipped with a Bernas type ion source and two experimental wafer processing end-stations. Capabilities of the laboratory are presented together with an introduction to the technology itself and its applications.

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IN INDUSTRIAL PRACTICE*

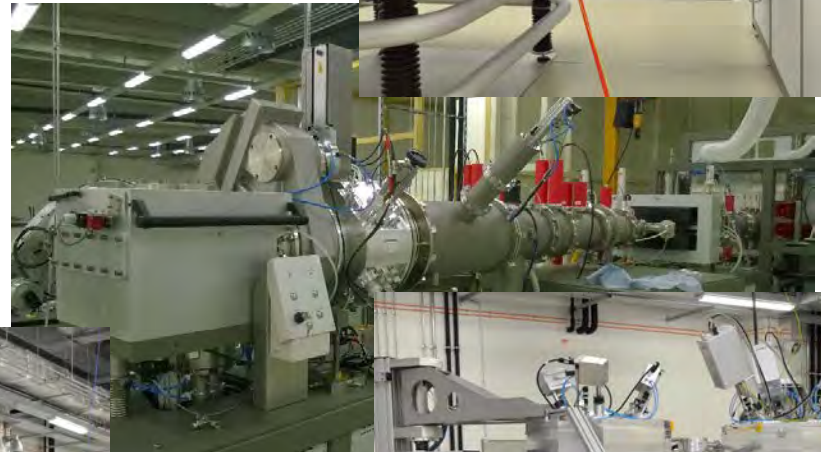
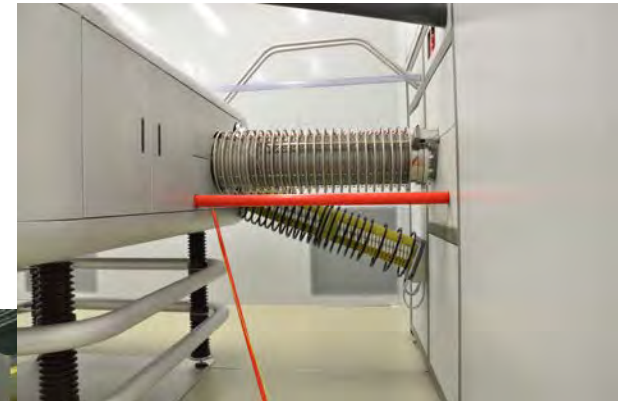
ION BEAM ANALYSIS AND MODIFICATION OF MATERIALS AT ATRI MTF STU

Pavol Noga

NEW LABS AT ATRI MTF STU



NEW EQUIPMENT



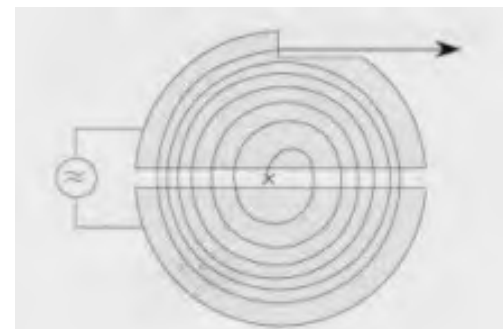
OUTLINE

- **Introduction to ion beams**
- **Ion beam modification of materials**
 - Ion implantation
 - Ion irradiation induced changes in structure
 - Ion irradiation induced activation
- **Equipment**
- **Ion beam analysis of materials**
 - Rutherford Backscattering Spectrometry
 - Elastic Recoil Detection Analysis
 - Ion Channeling
 - Particle induced x-ray emission
 - Nuclear reaction analysis

Electrostatic

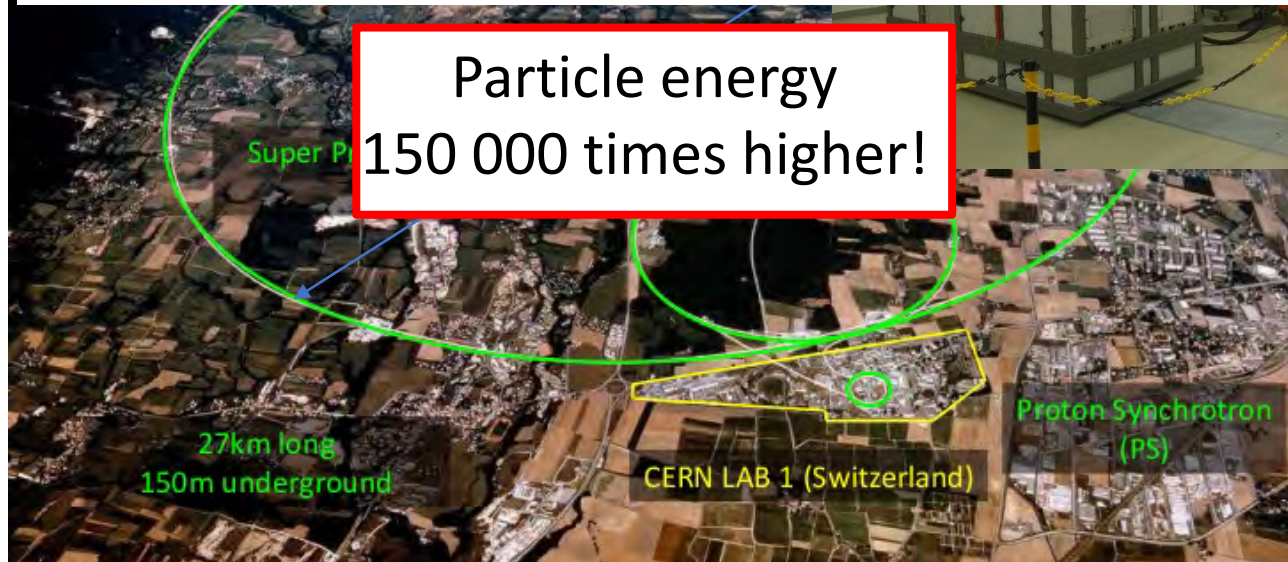
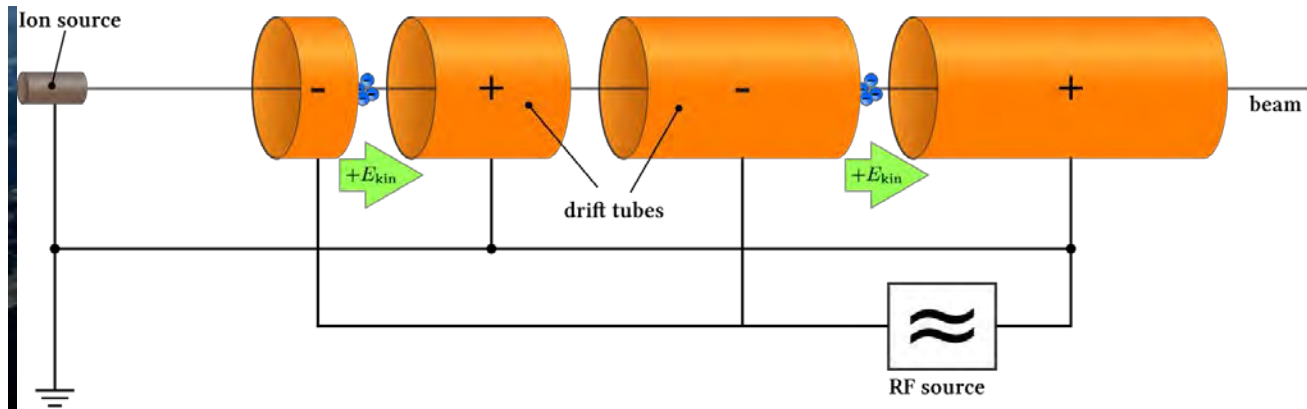


Cyclotron



BY NO MEANS „SMALL CERN“

CERN uses this



WHAT IS IT GOOD FOR?

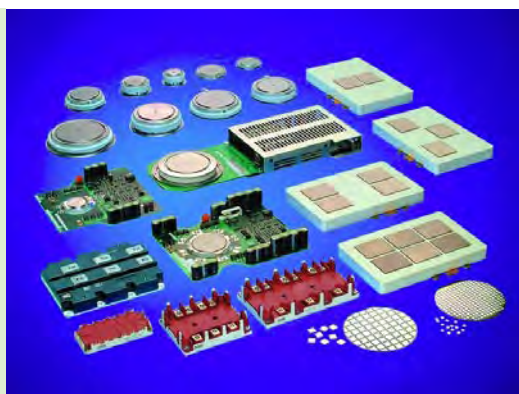
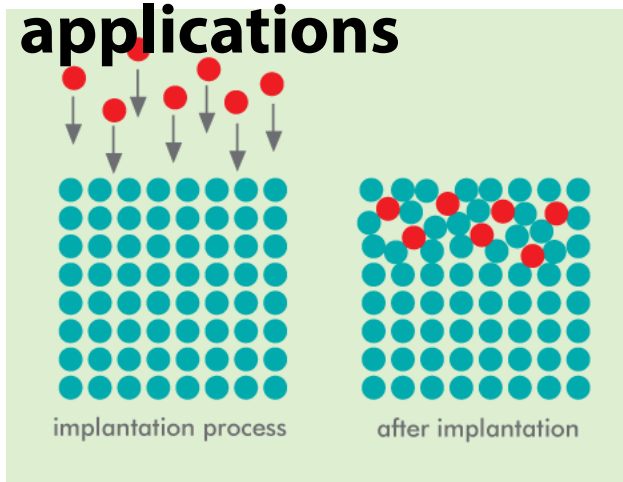
- **Exploring physics of matter and the Universe (CERN)**

Closer to everyday life and what we do:

- **Ion beam modification of materials**
 - Doping, synthesis of otherwise infeasible materials
 - Structure (tuning crystallinity, interface mixing etc.)
 - Activation and isotope production
- **Ion beam analysis of materials**
 - Elemental composition, contamination, trace elements
 - Structure

ION BEAM MODIFICATION

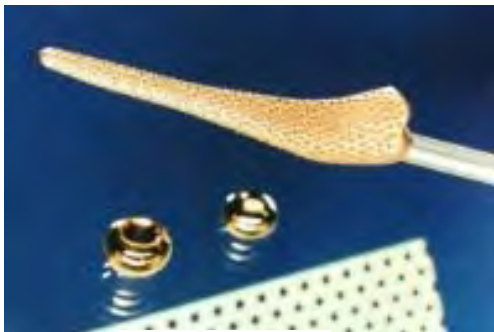
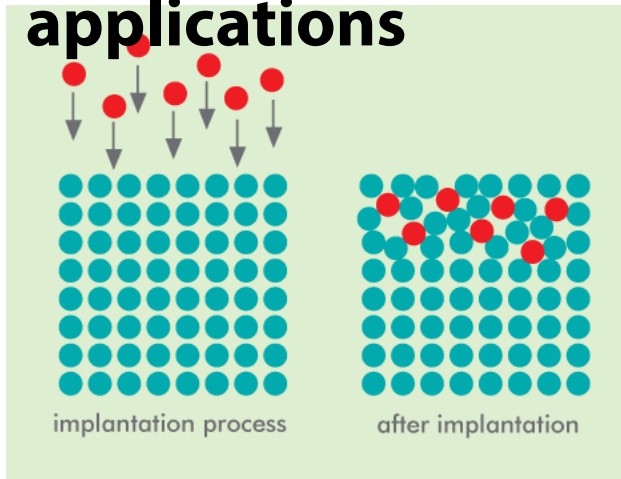
Well known: Ion implantation and its applications



All kinds of electronics

ION BEAM MODIFICATION

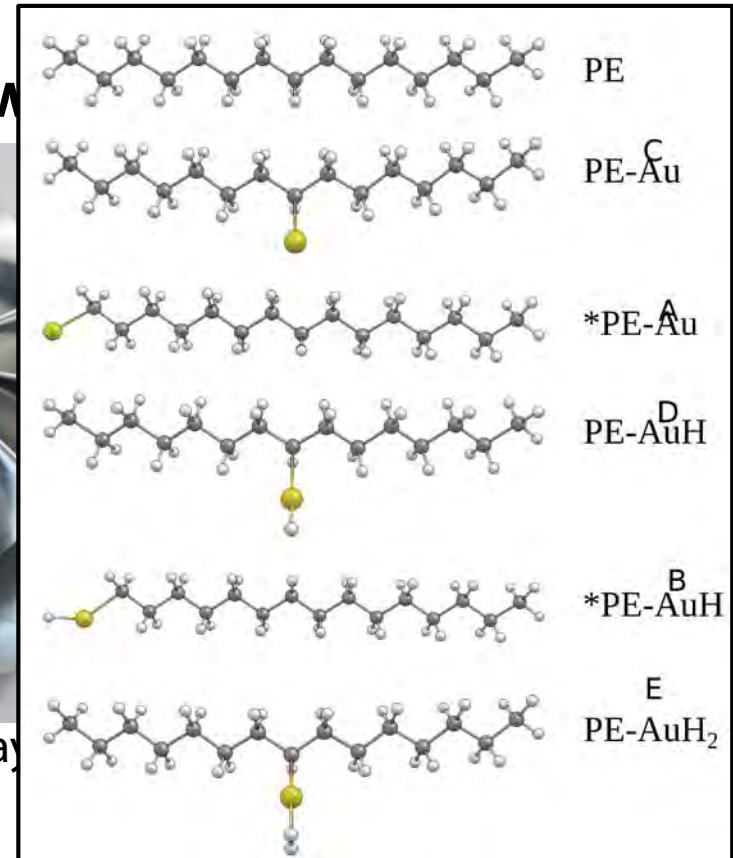
Ion implantation and its less known applications



Biocompatibility



Wear resistant layer

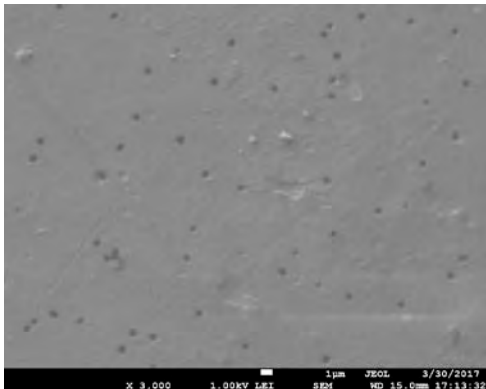


And many more...

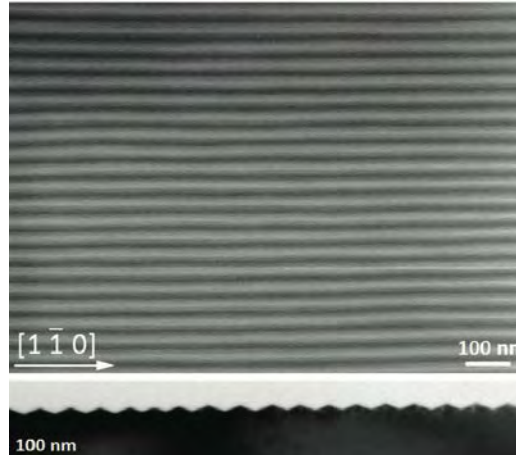
ION BEAM MODIFICATION

Tuning the structure

- Amorphous to crystalline and vice versa
- Interface mixing
- Ion beam annealing
- Nanostructures

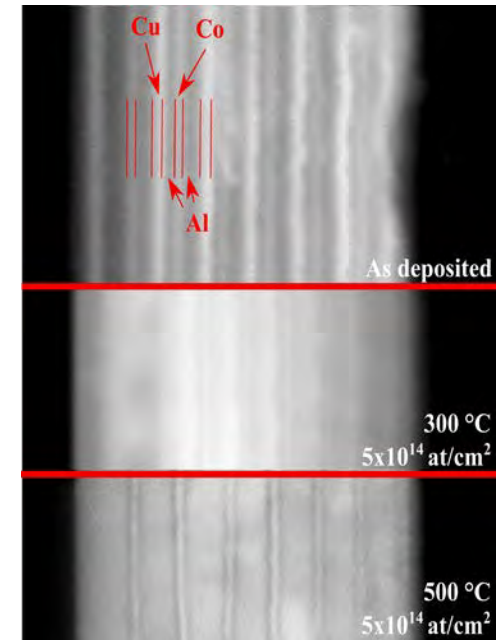


Ion-tracks



Self assembled nanostructures

X. Ou et Al. Nanoscale, 2015, 7, 18928



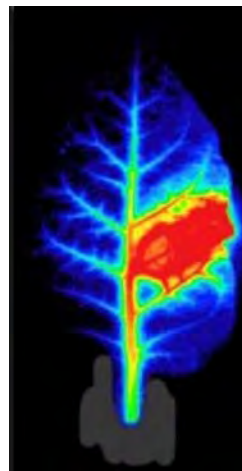
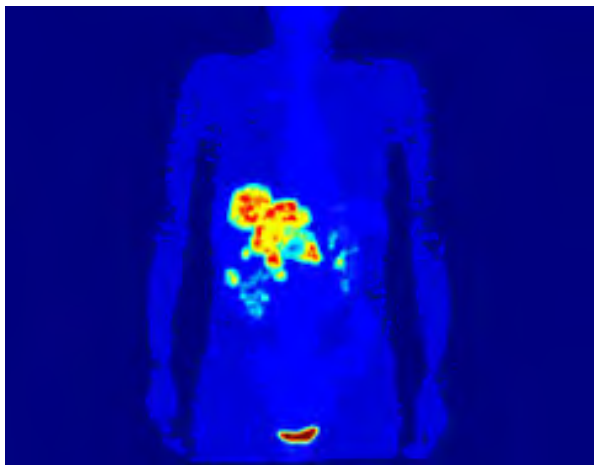
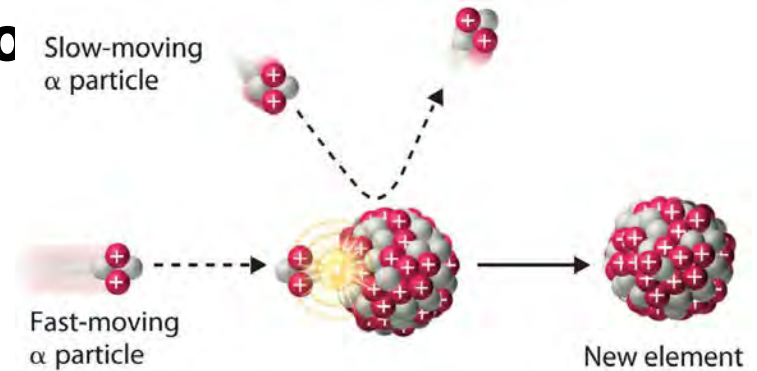
Ion beam mixing

Applications in optics, data storage, molecular filters, functional layers etc.

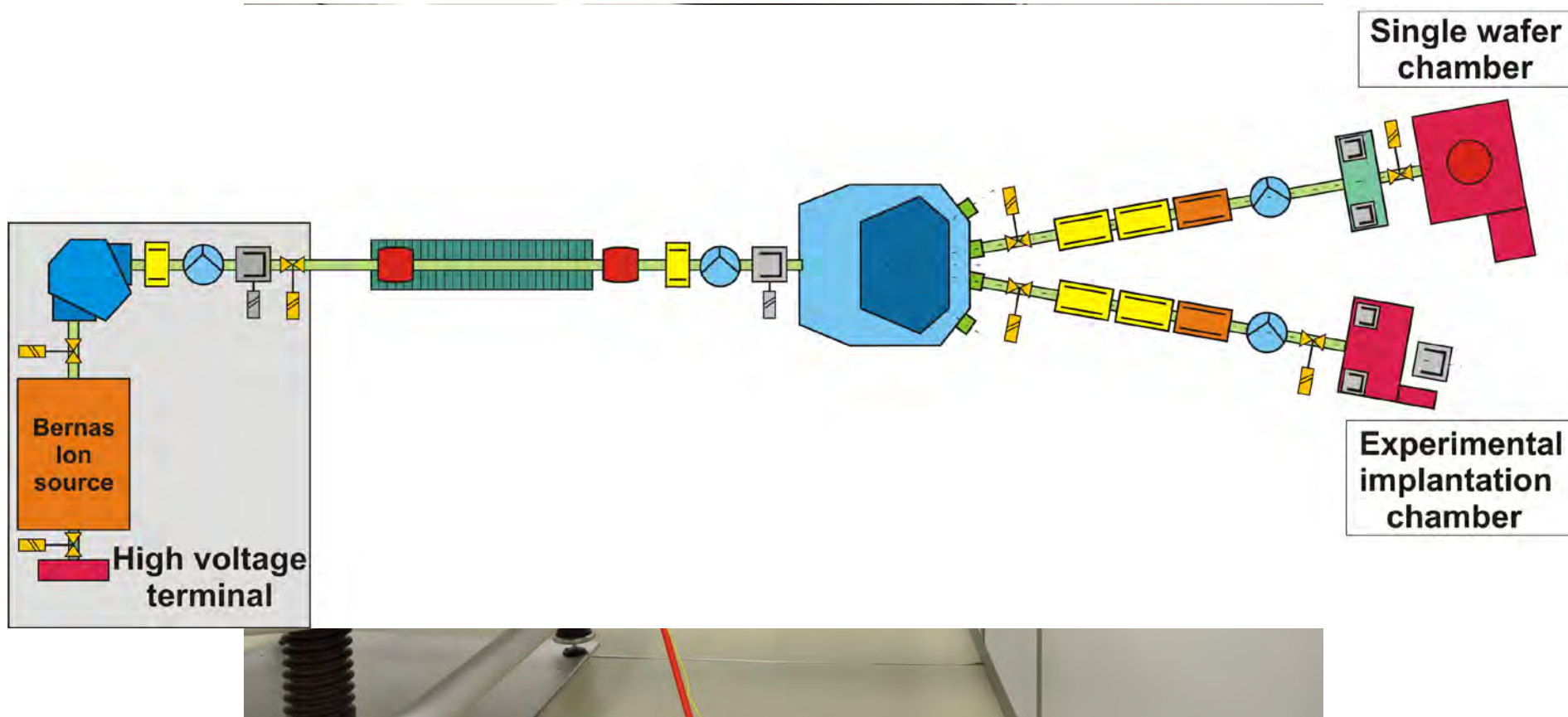
ION BEAM MODIFICATION

Activation and isotope production

- **Nano-wear measurement**
e.g. in engines, compressors, bearings etc.
- **Cancer diagnostics and treatment**
- **Exotic radionuclides used as markers**
e.g. migration of nutrients in plants, diffusion measurements etc.



EQUIPMENT: ION IMPLANTER



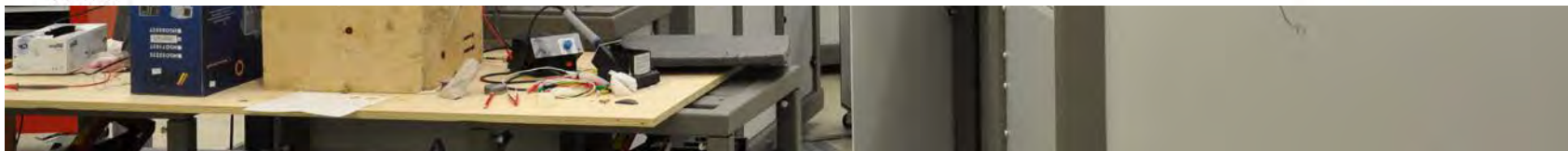
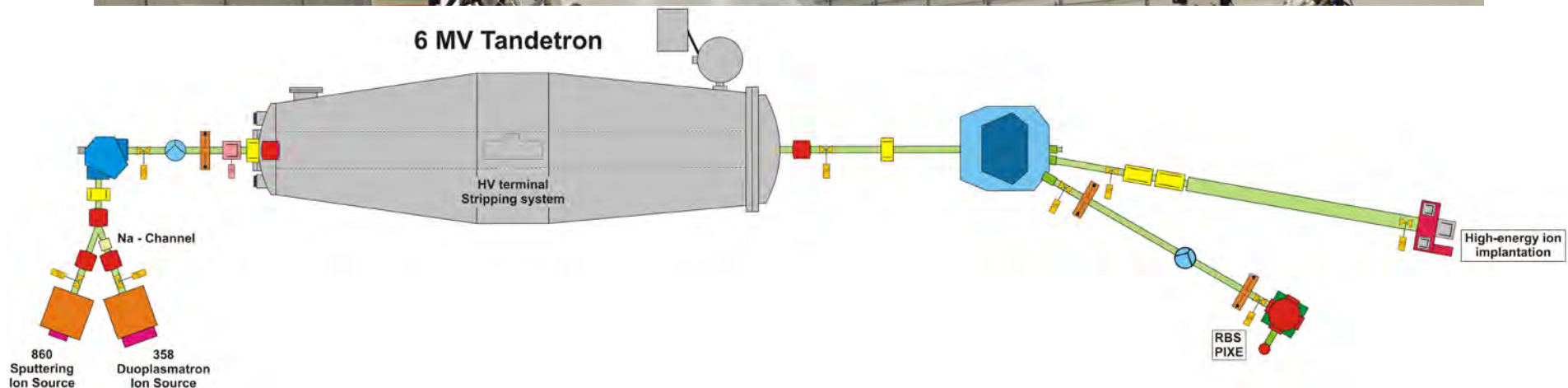
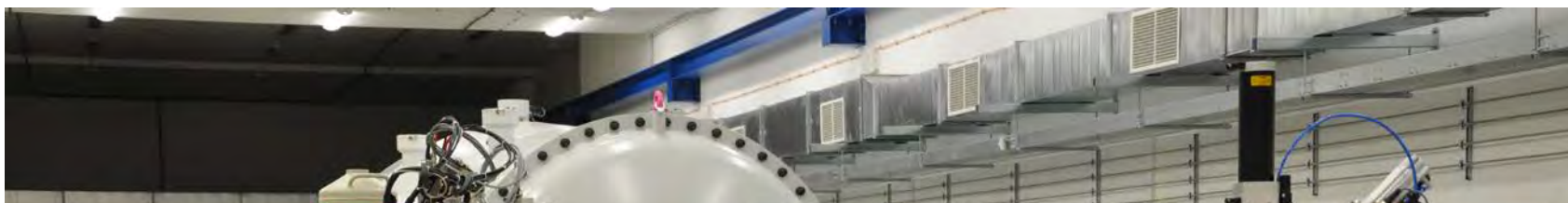
ION IMPLANTATION END-STATIONS



6 MV TANDEM ION ACCELERATOR



6 MV TANDEM ION ACCELERATOR

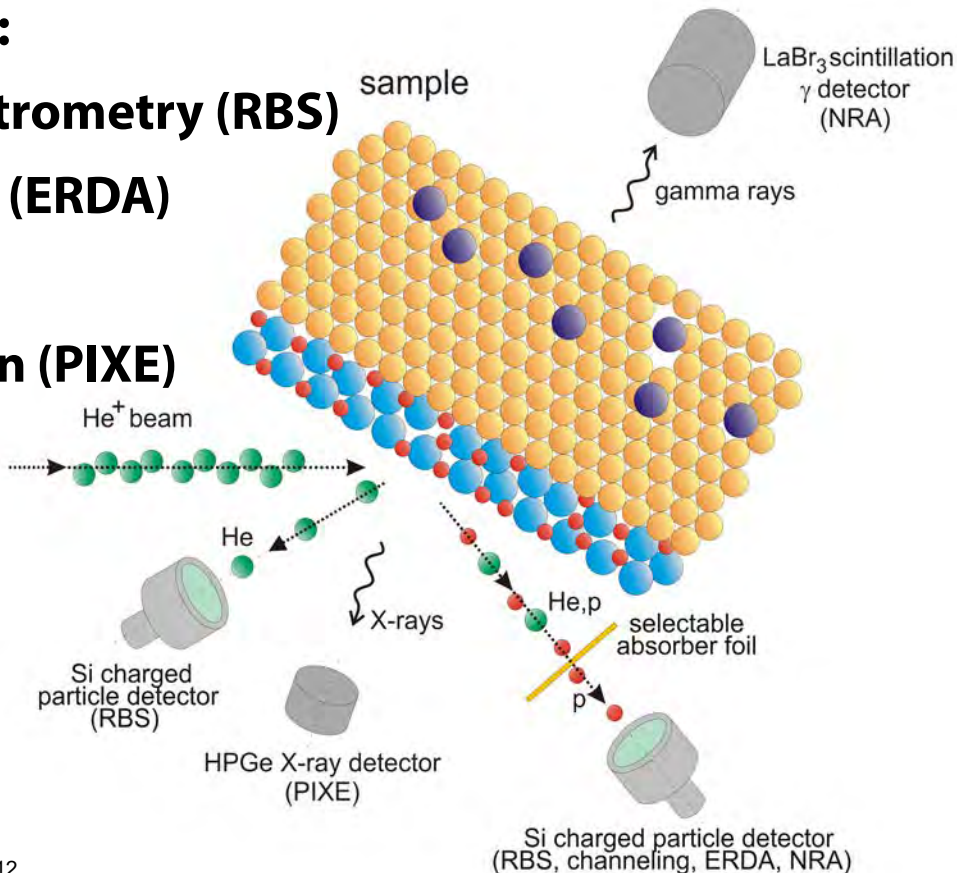


ION BEAM ANALYSIS

Non-destructive method for materials analysis

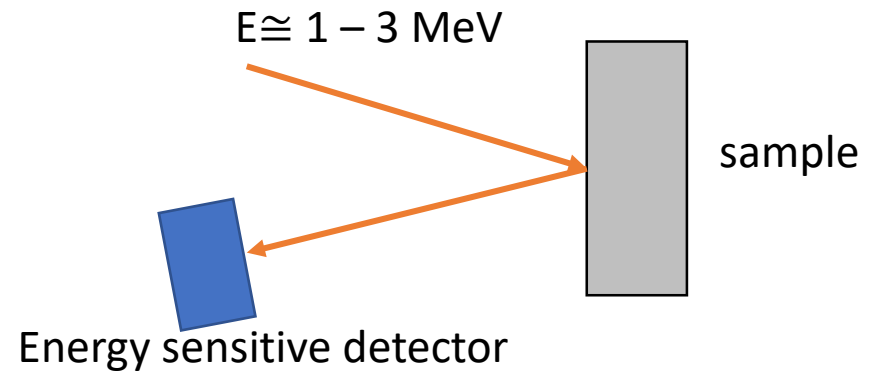
Detects any element of the Periodic table utilizing the whole palette of ion-matter interactions:

- Rutherford Backscattering Spectrometry (RBS)
- Elastic Recoil Detection Analysis (ERDA)
- RBS – Channeling (RBS/c)
- Particle Induced X-ray Emission (PIXE)
- Nuclear Reaction Analysis (NRA)

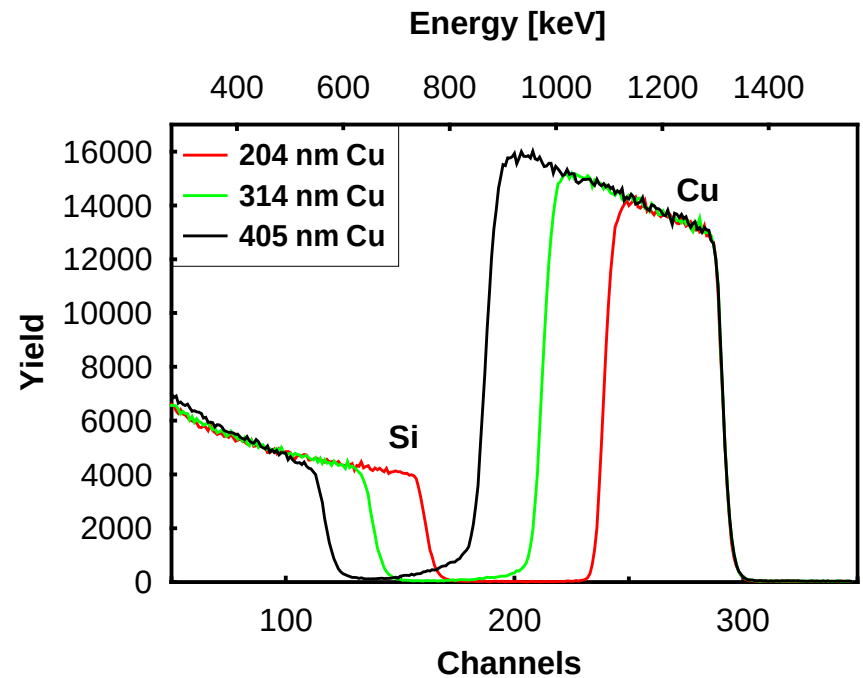
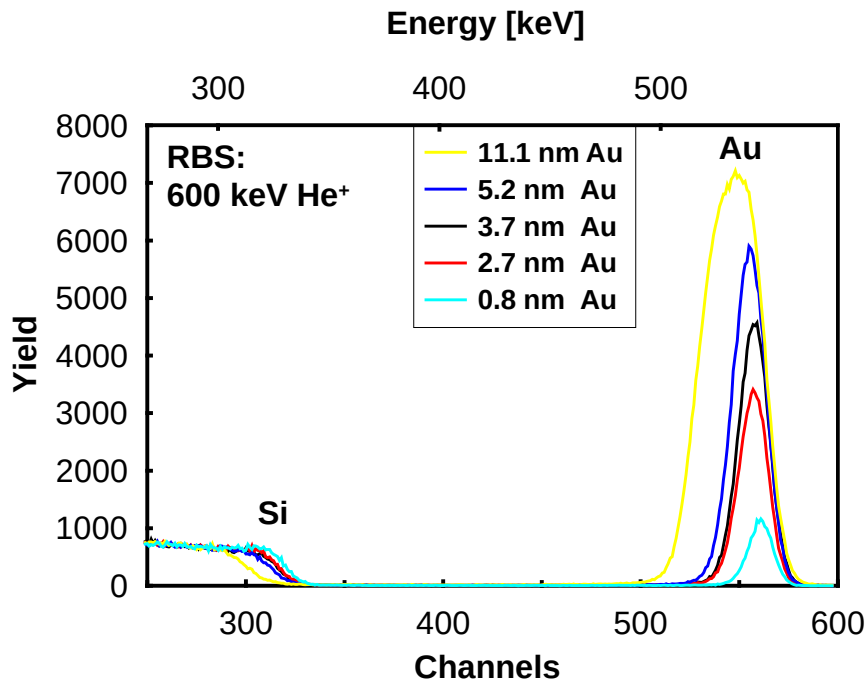


RUTHERFORD BACKSCATTERING SPECTROMETRY

- **Near surface / thin layer analysis**
- **Concentration depth profiling**
- **Quantitative and standard-free**
- **Analysable elements: O to U**
- **Analyzed depth up to 20 μm**
- **Depth resolution 2 – 20 nm**
- **Very sensitive to heavy elements in a light matrix or substrate**
- **Insensitive to light elements in a heavy matrix or substrate**
- **Detection limit (heavily depend on the sample) down to 0.001 at%**

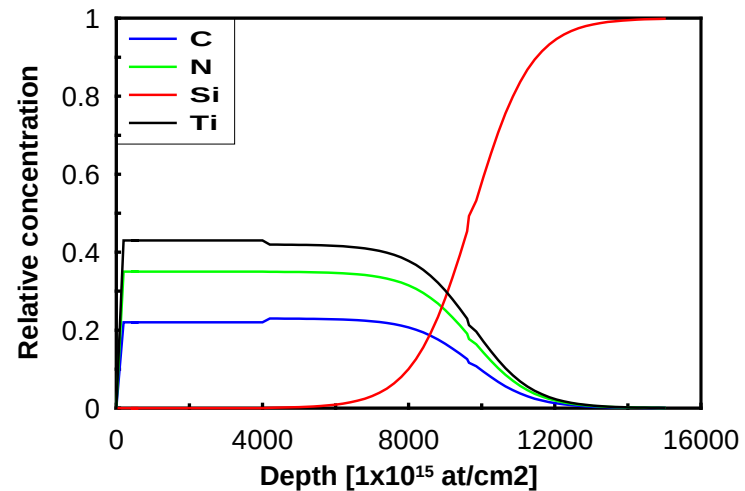
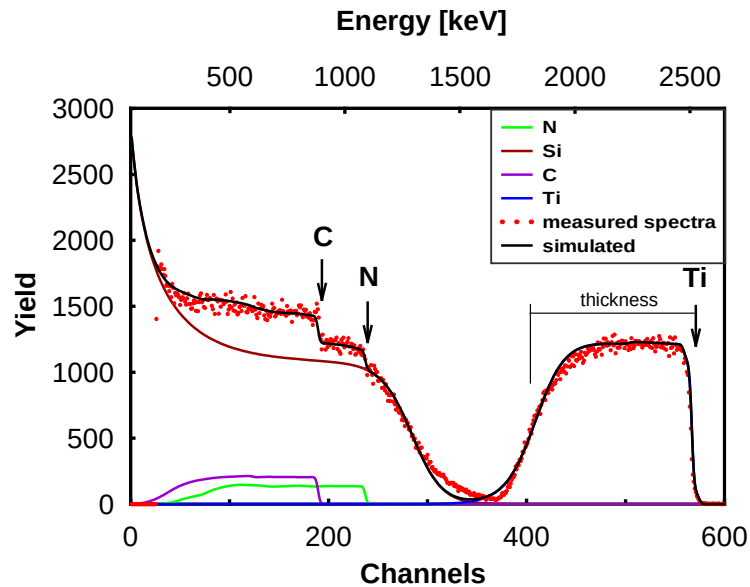


RUTHERFORD BACKSCATTERING SPECTROMETRY



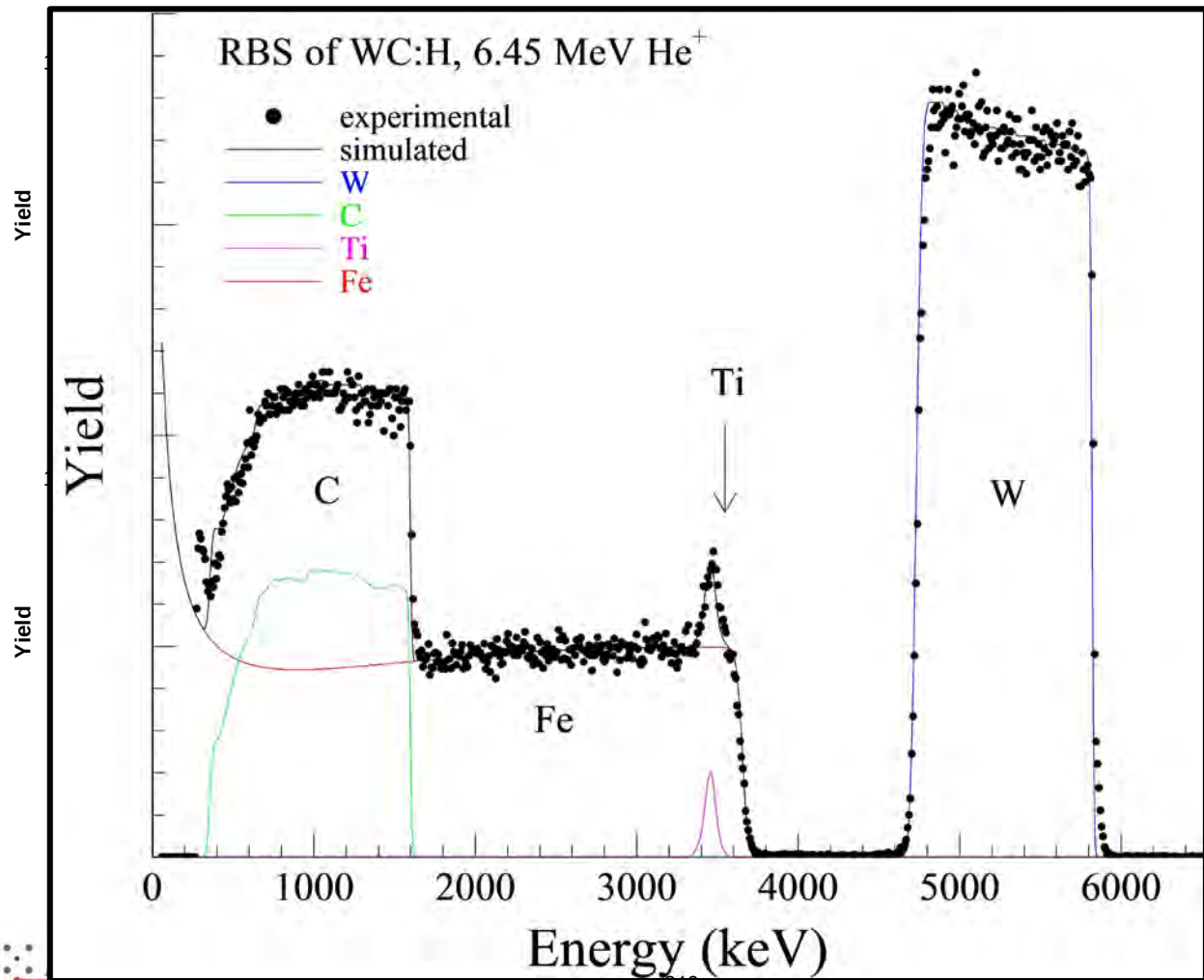
Measuring thin-layer thickness

RUTHERFORD BACKSCATTERING SPECTROMETRY



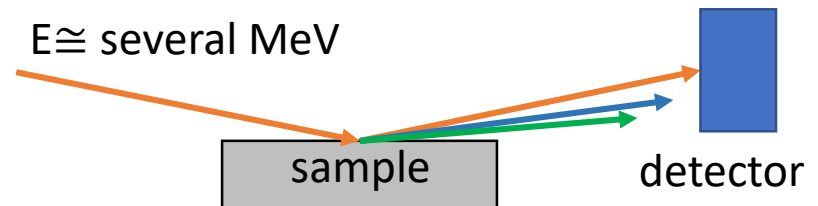
Measuring concentration profiles

NON-RUTHERFORD BACKSCATTERING SPECTROMETRY

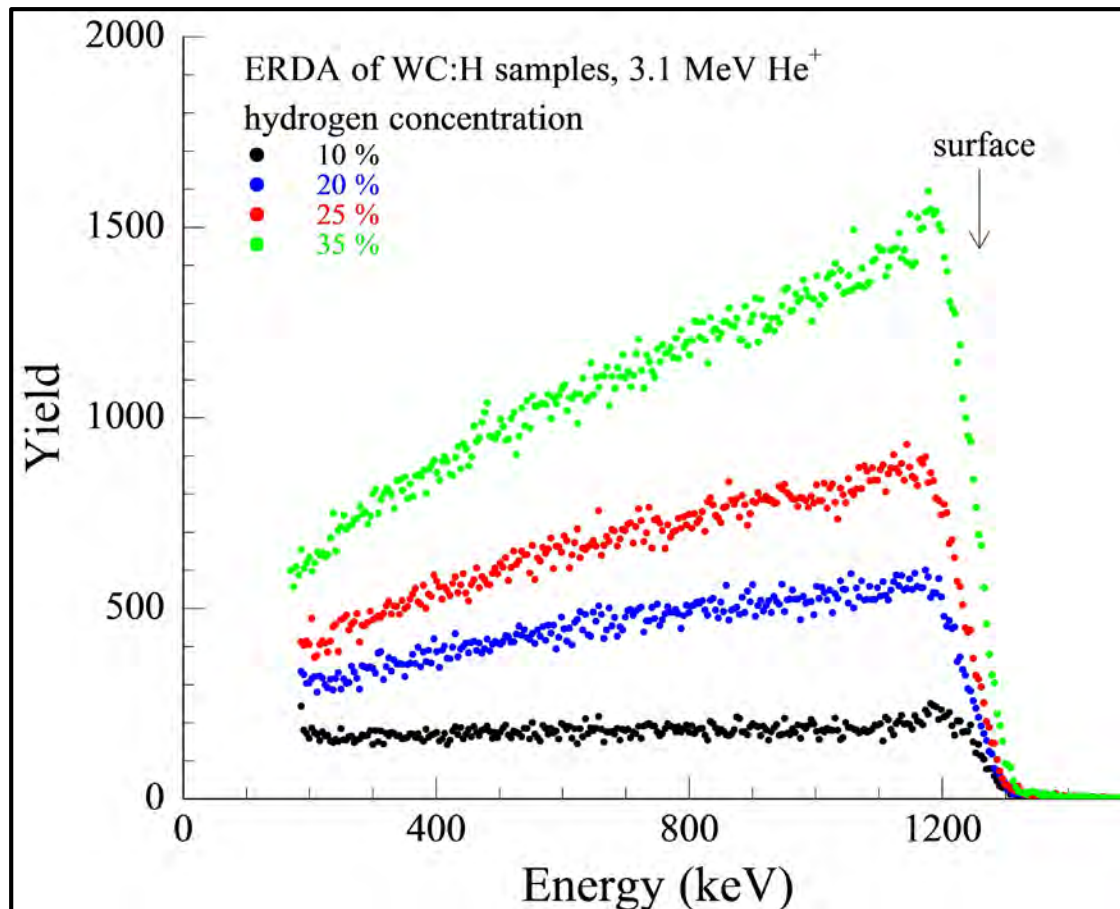


ELASTIC RECOIL DETECTION ANALYSIS

- **Concentration depth profiling**
- **Quantitative and standard-free**
- **Analysable elements: H to U (at ATRI only H at the moment, extension planned soon)**
- **Analyzed depth up to 1 μm**
- **Depth resolution 20 - 50 nm**
- **Sensitive to light elements in a heavy matrix or substrate**
- **Insensitive to heavy elements in a light matrix or substrate**
- **Detection limit: 0.01 at%**

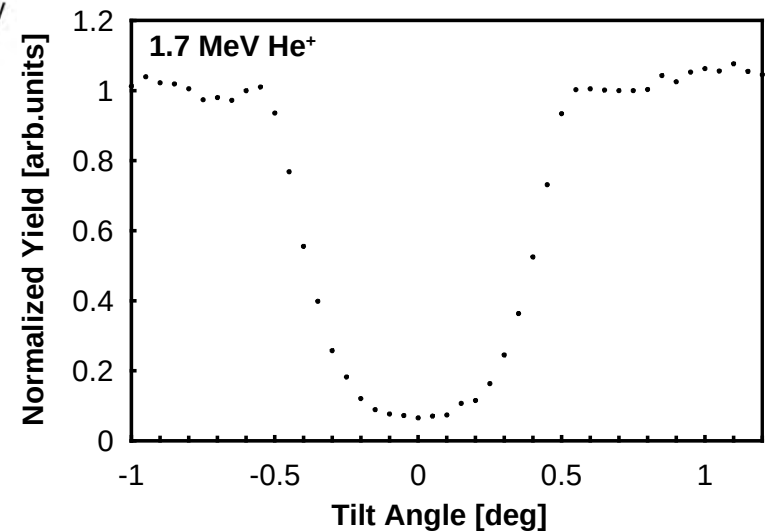
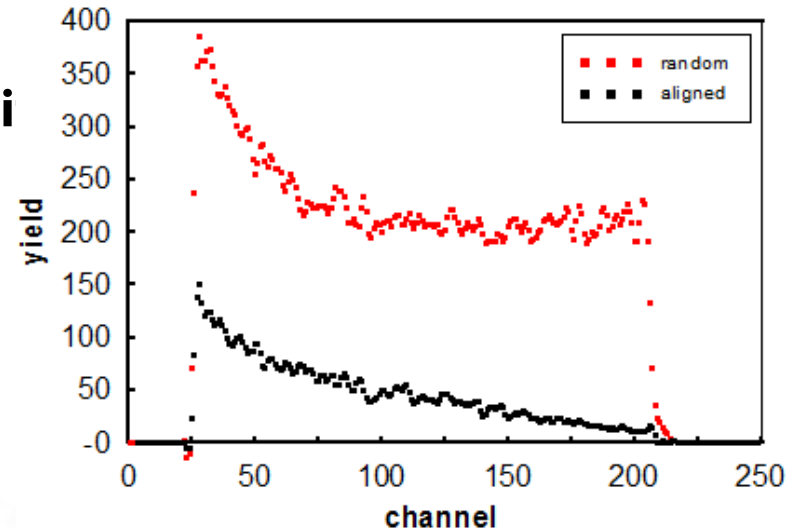
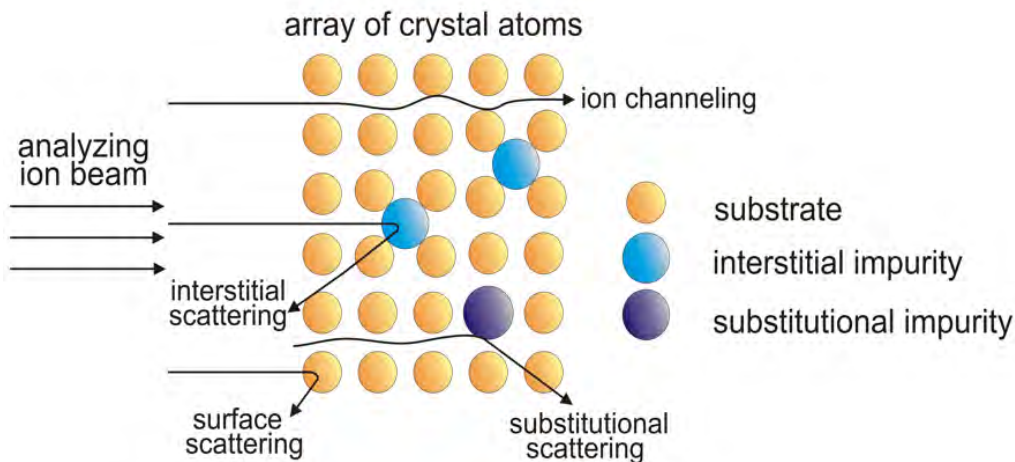


ELASTIC RECOIL DETECTION ANALYSIS



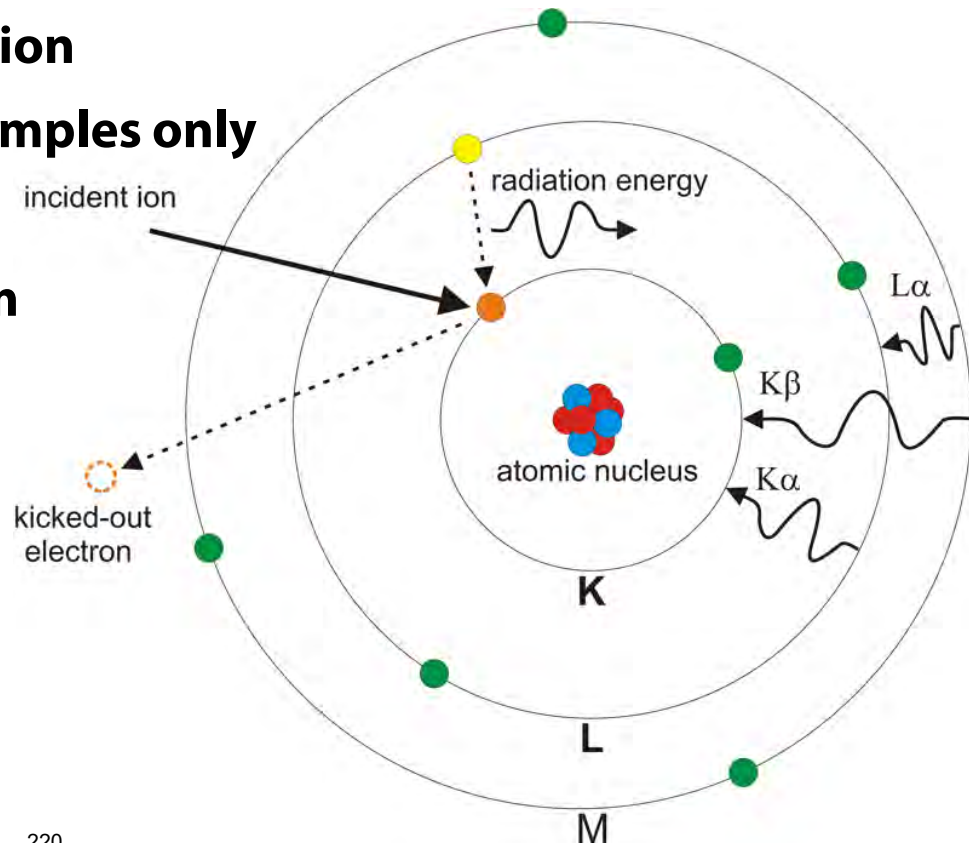
ION CHANNELING (RBS/C)

- Gives information on the crystal quality defects and degree of amorphization

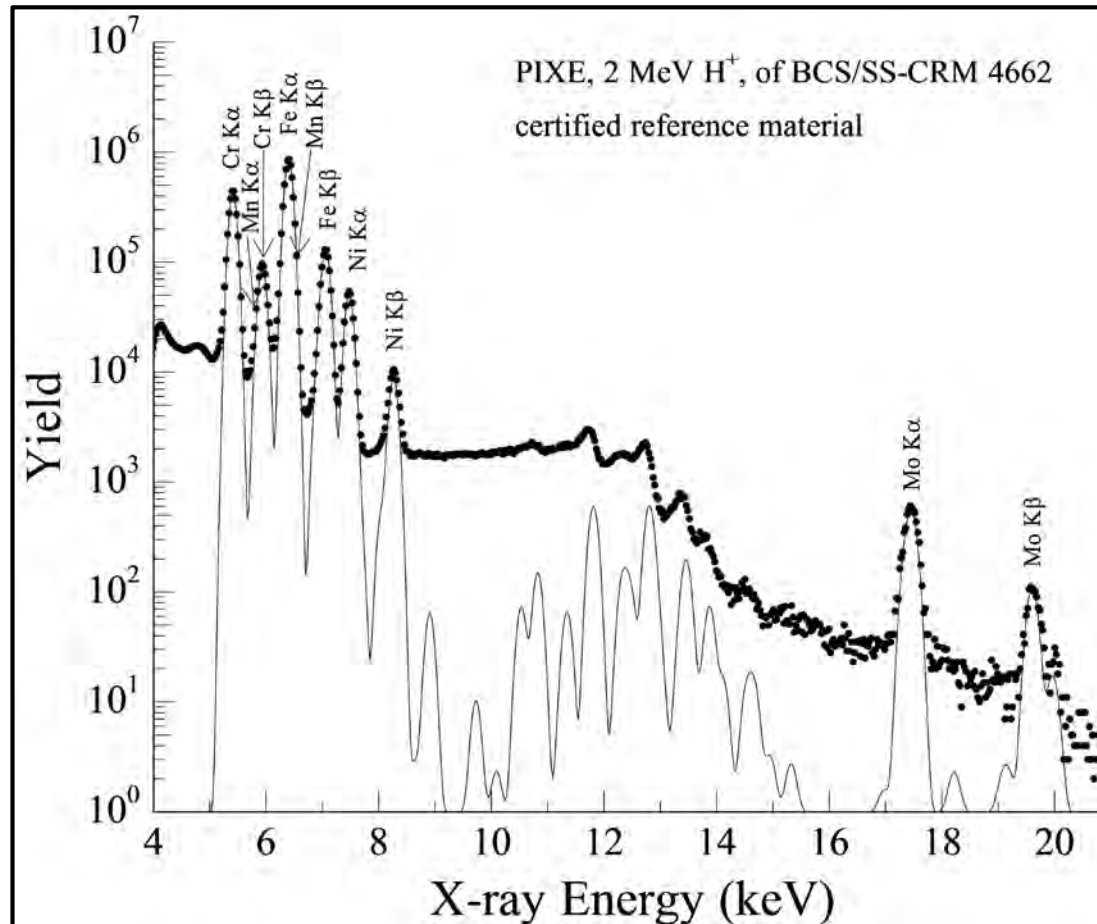


PARTICLE INDUCED X-RAY EMISSION

- Sensitive trace element detection
- Quantitative with reference samples only
- Analysable elements: Na to U
- Analyzed depth up to 5 - 10 μm
- No depth resolution
- Detection limits sub-ppm

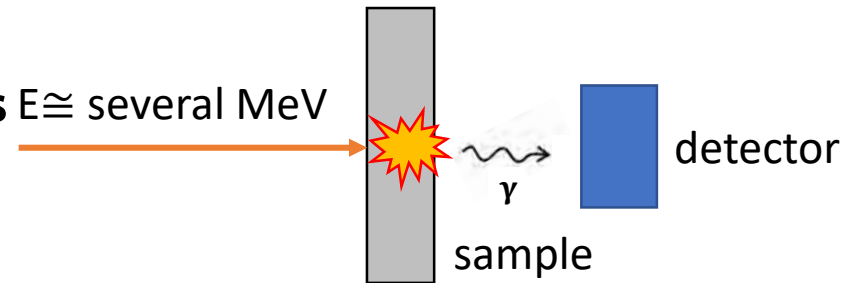


PARTICLE INDUCED X-RAY EMMISSION



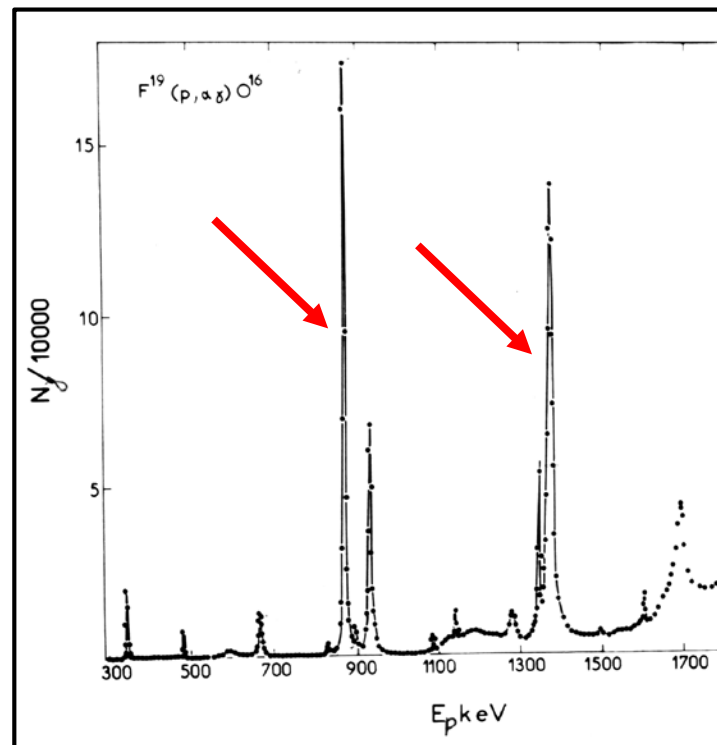
NUCLEAR REACTION ANALYSIS

- **Selective analysis of light elements** $E \cong$ several MeV
- **Isotope sensitive**
- **Concentration depth profiling**
- **Analysable elements: H to P**
- **Analyzed depth up to 5 μm**
- **Depth resolution 10 nm (matrix dependent), 1 nm at grazing incidence**
- **Detection limit: 0.001 - 1 at%**

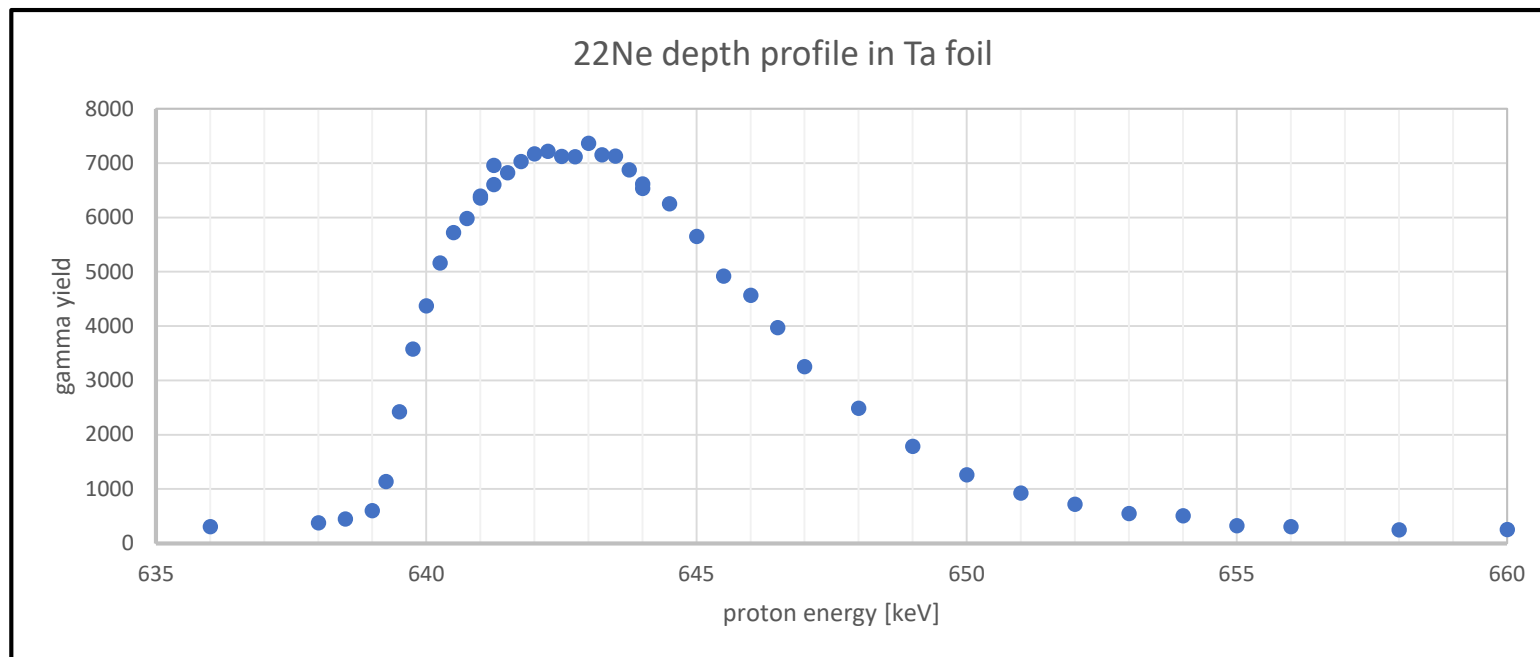


NUCLEAR REACTION ANALYSIS

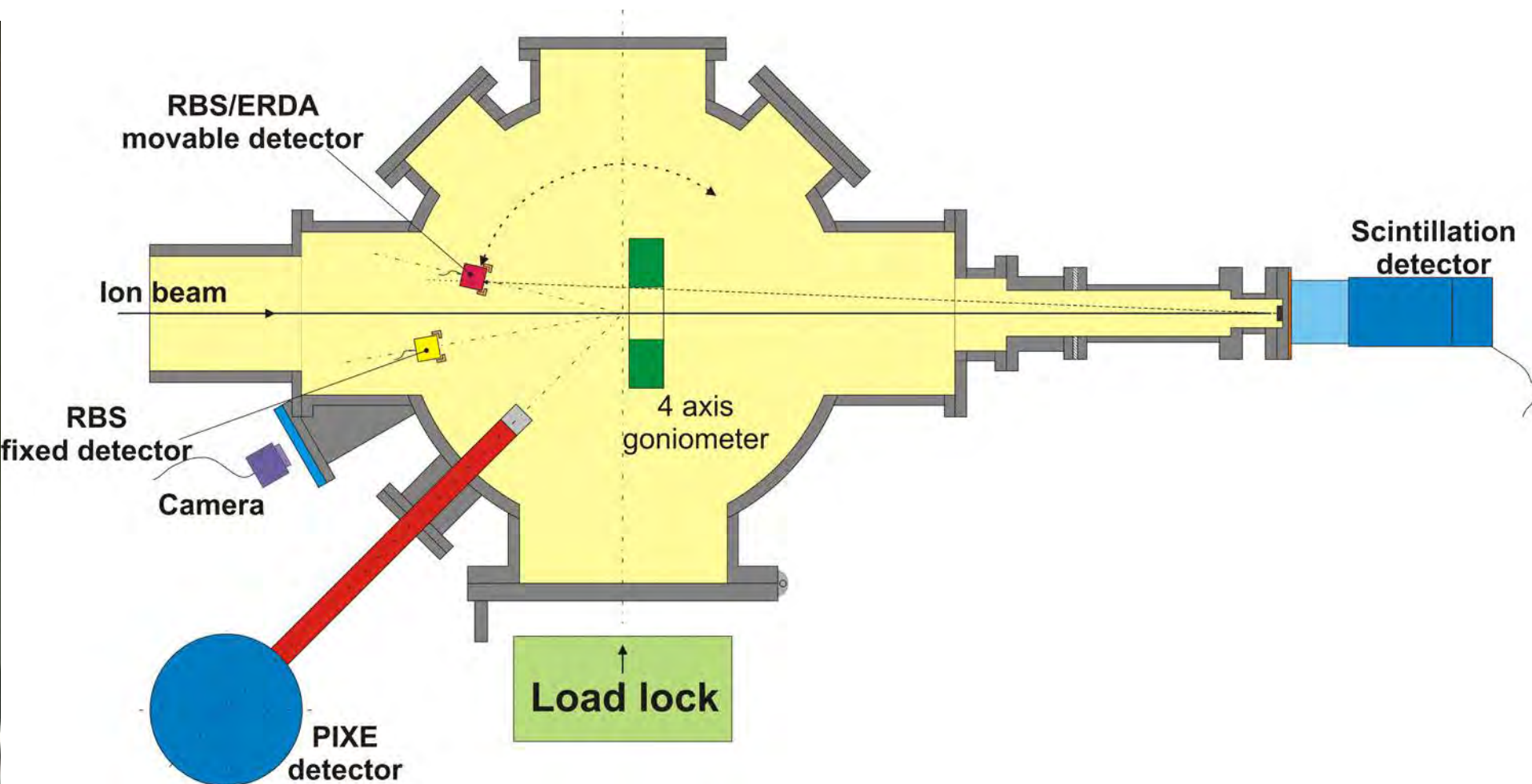
We take advantage of the fact, that some nuclear reactions take place in a narrow energy range, i.e. they have resonances, where the probability of these reactions to happen, rises by orders of magnitude



NUCLEAR REACTION ANALYSIS

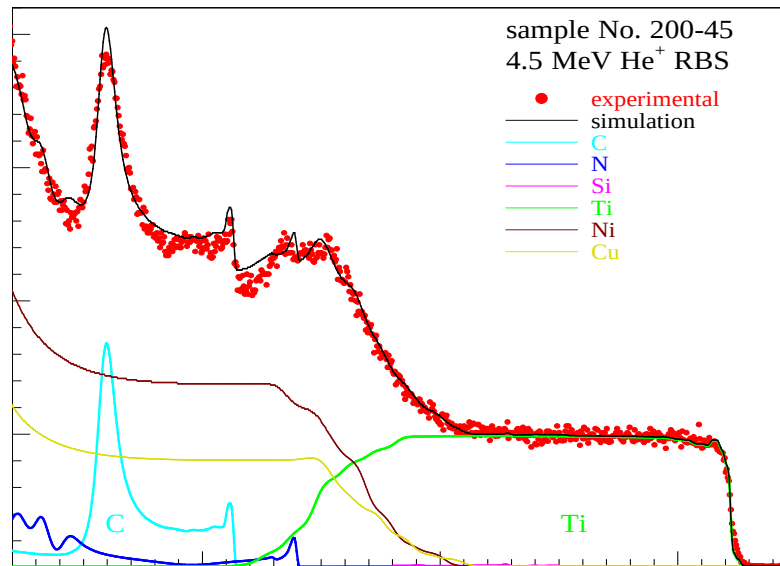


ANALYSIS END-STATION



ION BEAM ANALYSIS

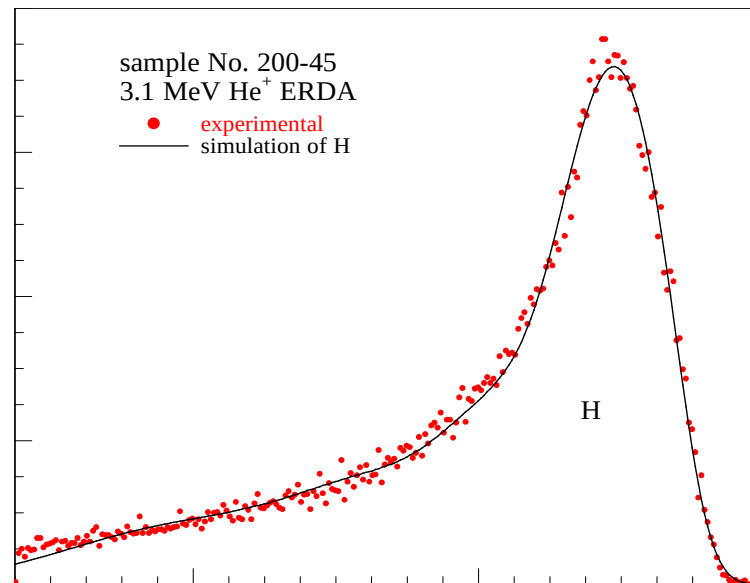
Combination of IBA techniques gives the full information



Take the first information from RBS

ION BEAM ANALYSIS

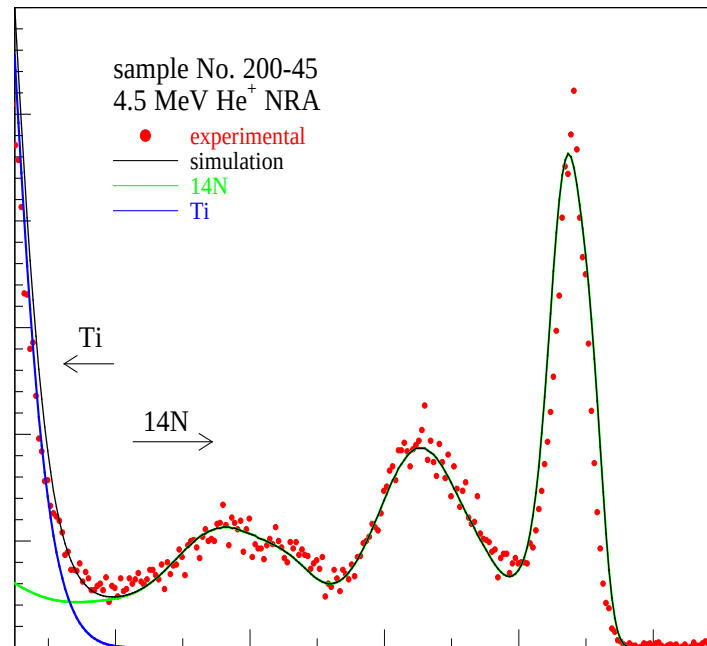
Combination of IBA techniques gives a complex elemental depth profile



Add ERDA to determine hydrogen content

ION BEAM ANALYSIS

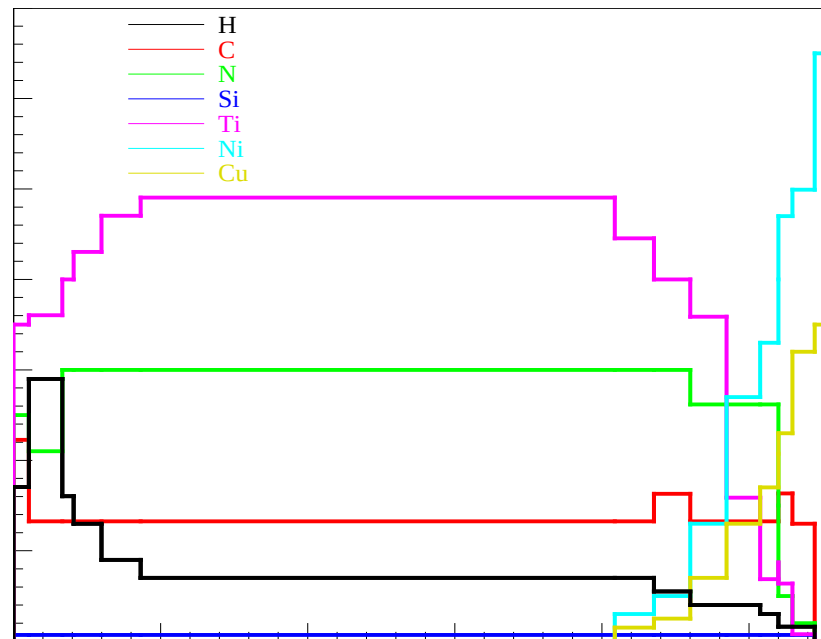
Combination of IBA techniques gives a complex elemental depth profile



Improve accuracy and cross-check with NRA

ION BEAM ANALYSIS

Combination of IBA techniques gives a complex elemental depth profile



Put together and deliver the depth profile

CREDITS

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Maximilián Strémy

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ACKNOWLEDGMENT

This work was financially supported by:

- The European Regional Development Fund, Research and Development Operational Programme, project No. ITMS:26220220179,
- The European Commission under Horizon 2020, contract No. 664526
- The Slovak Research and Development Agency under contract No. APVV-15-0049
- Grant Agency VEGA under contracts No. 1/0018/15, 1/0503/15, 1/0219/16, 1/0330/18
- The Ministry of Education, Science, Research and Sport of the Slovak Republic under contract No. 003STU-2-3/2016.





THANK YOU FOR ATTENTION!



VIDEO PROCESSING RESEARCH AT FIT

Ing. Roman Juránek, PhD. ¹

¹ University of Technology, Brno

Abstract

In this talk, I will introduce active research topics in the field of traffic surveillance on Faculty of Information Technology, Brno University of Technology. I will talk mainly about detection of vehicles, license plate recognition, and vehicle speed measurement which I will present in more detail. Precise measurement of vehicle speed from a single camera is active research topic since it potentially offers cheaper installation compared to current industrial practice. It requires only one camera capturing multiple vehicles simultaneously. The main part of the measurement is calibration of the camera. In most cases today, the calibration is solved either by patterns (e.g. checkerboard) or manually. We developed methods that can automatically calibrate the camera just by observing passing vehicles.

We captured a large dataset with precisely annotated speeds of passing vehicles and evaluated our method which gives mean speed estimation error of 1.1 kph. The dataset is freely available for non-commercial purposes.

Automatic vehicle speed measurement

And other traffic applications

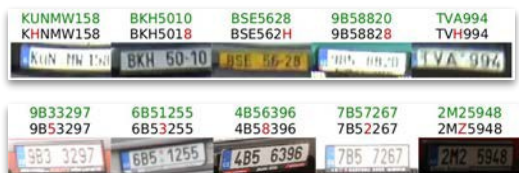
Roman Juranek, Brno University of Technology

3rd International conference, 3D Measurement and Imaging
Modern contactless measurements in industrial practice
10 - 11.10. 2018, Bratislava, SK

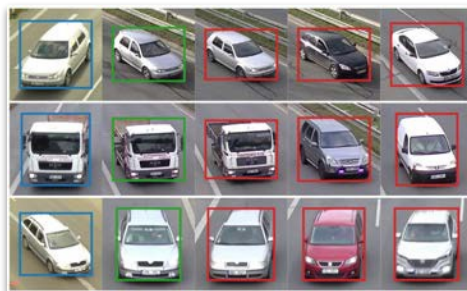
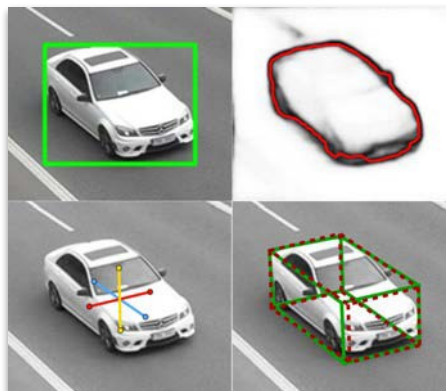


Research topics

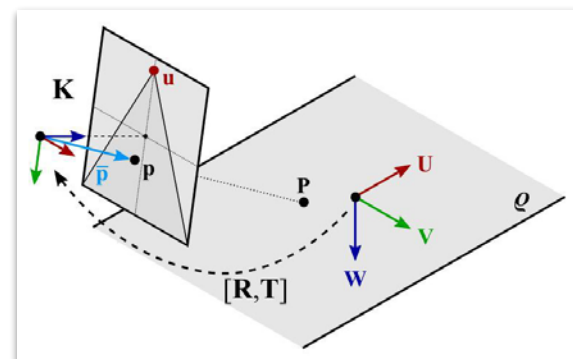
License plate detection and recognition



Vehicle detection, recognition, and re-identification



Camera calibration

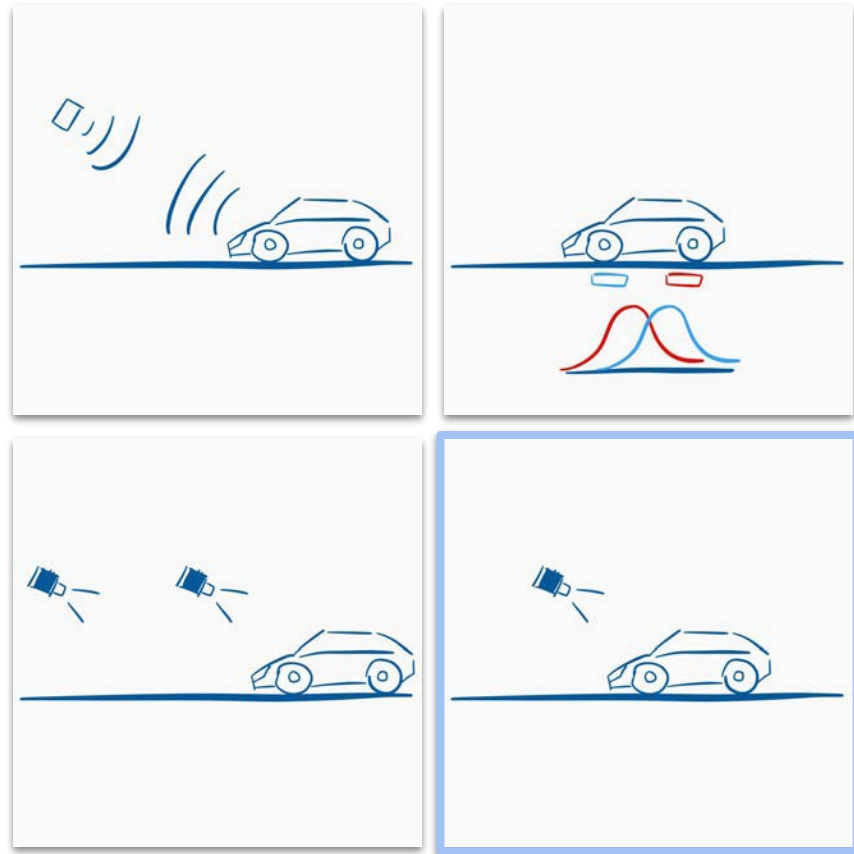


Speed measurement

Sensors

- Radar
- Inductive loops
- Section speed - two cameras
- Single camera

Radars and loops are usually equipped with cameras to capture license plate



Speed measurement

Scenarios

- Industrial/Law enforcement
 - Accuracy better than **3 km/h**
 - Often one camera per lane
 - High resolution, IR flash, **controlled conditions**
 - Mostly section speed
- Overview cam - informative only
 - **Single camera** capturing all lanes, low resolution
 - For other applications like **traffic volume**, **travel time** estimation, etc.



Single camera speed measurement

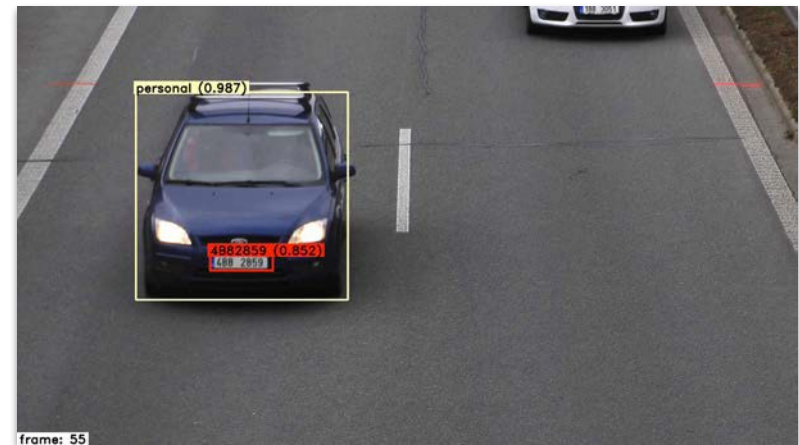
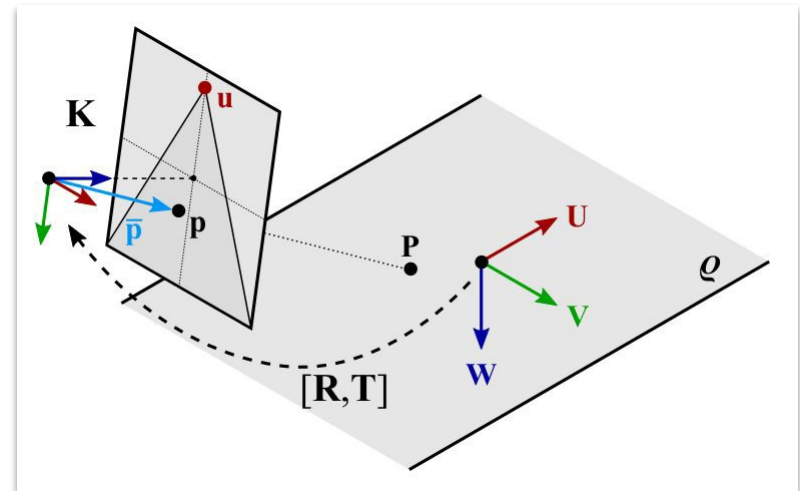
Camera calibration - **K**, **R** and **T** parameters

- Intrinsic parameters (focal length)
- Orientation
- Height above road

Vehicle detection and tracking

Traveled distance calculation

$$v = s / t$$



Typical solutions

- Lots of research papers in last 20 years!
- Constraints on camera installation - front facing, known focal length and height above road
- Constraints on vehicle motion - linear motion
- Simple algorithms
- Mostly **not automatic**
- Often poor results or not evaluated at all
- There are NO common data for evaluation:(

So what did we do...

Fully automatic camera calibration

- (Almost) **no prior knowledge** about camera - **arbitrary view**
- **Linear motion** scenario (for speed measurement)
- **Arbitrary motion** scenario (parking lots, roundabouts, intersections)

Speed measurement from video

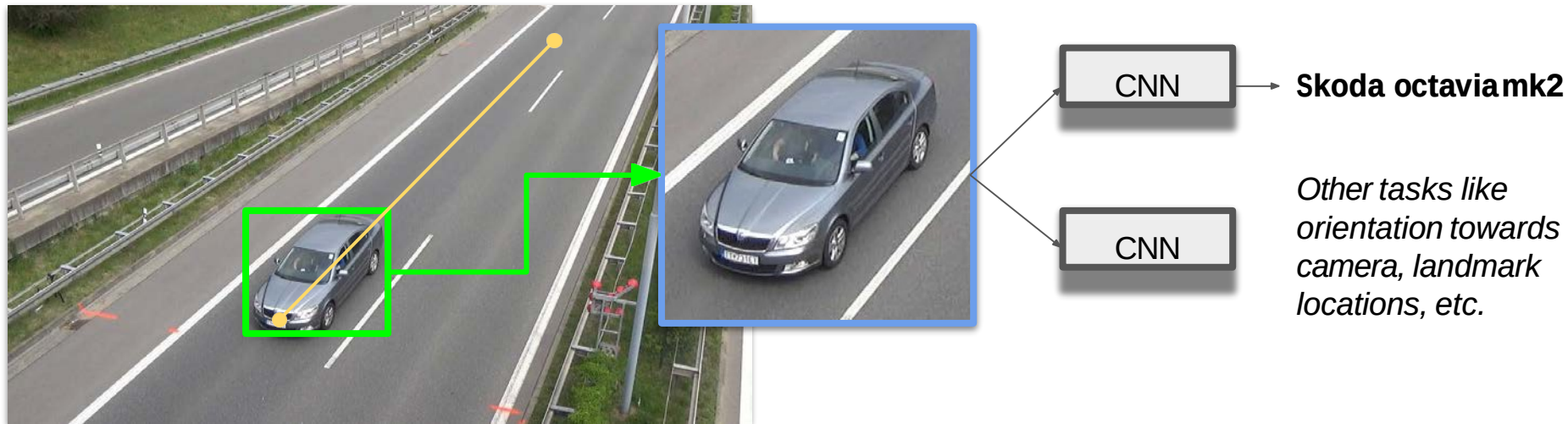
- Reliable **detection** and **tracking** and **classification** of vehicles

Datasets for **evaluation** and **benchmarking** of camera calibration and speed measurement

Detection, tracking and classification

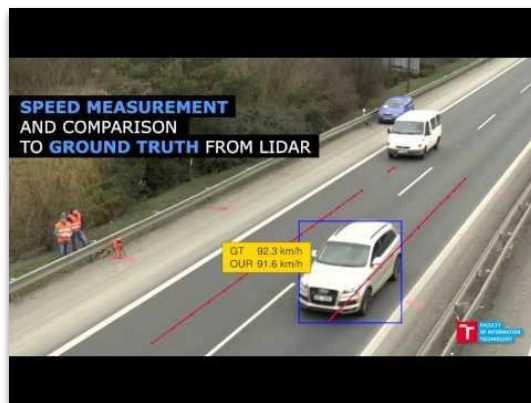
We use neural network-based tools

- **Faster-RCNN** detector
- Vehicle type **classifier** (make, model, year)



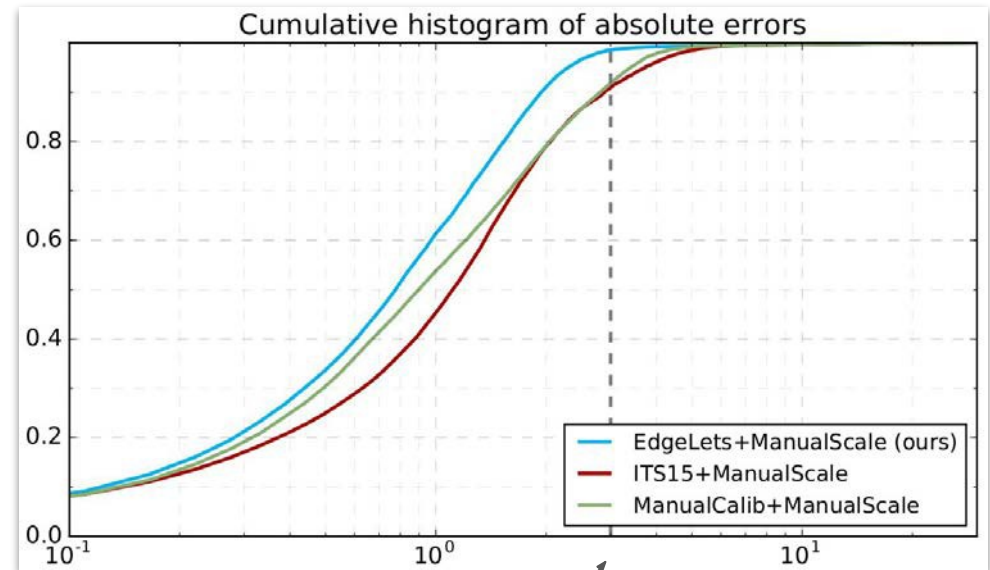
Linear motion case

- Detection of **vanishing points**
- **Detection** and **classification** of cars
- Alignment of known **3D shape** to observations



Accuracy

- Mean error **1.1 km/h**
- **99 % of observations** with error better than **3 km/h**
- **Max error > 10km/h** due to tracking errors



3 km/h

Arbitrary motion case

Work in progress

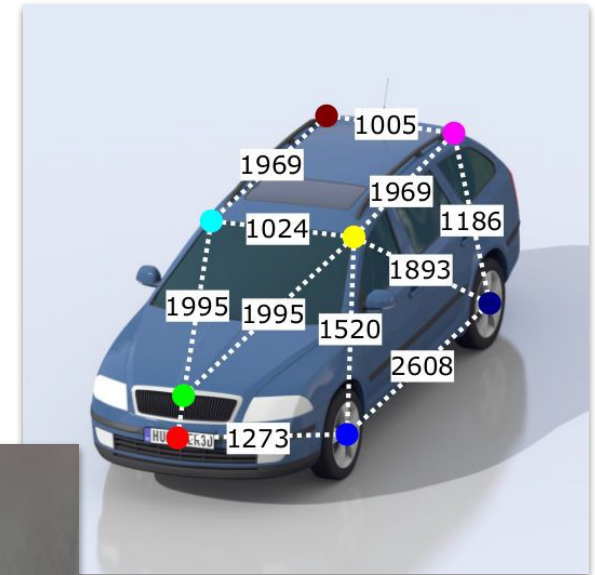
Detection and classification of cars

Landmarks on cars

Global optimization to find focal length, orientation of camera and its position in 3D space

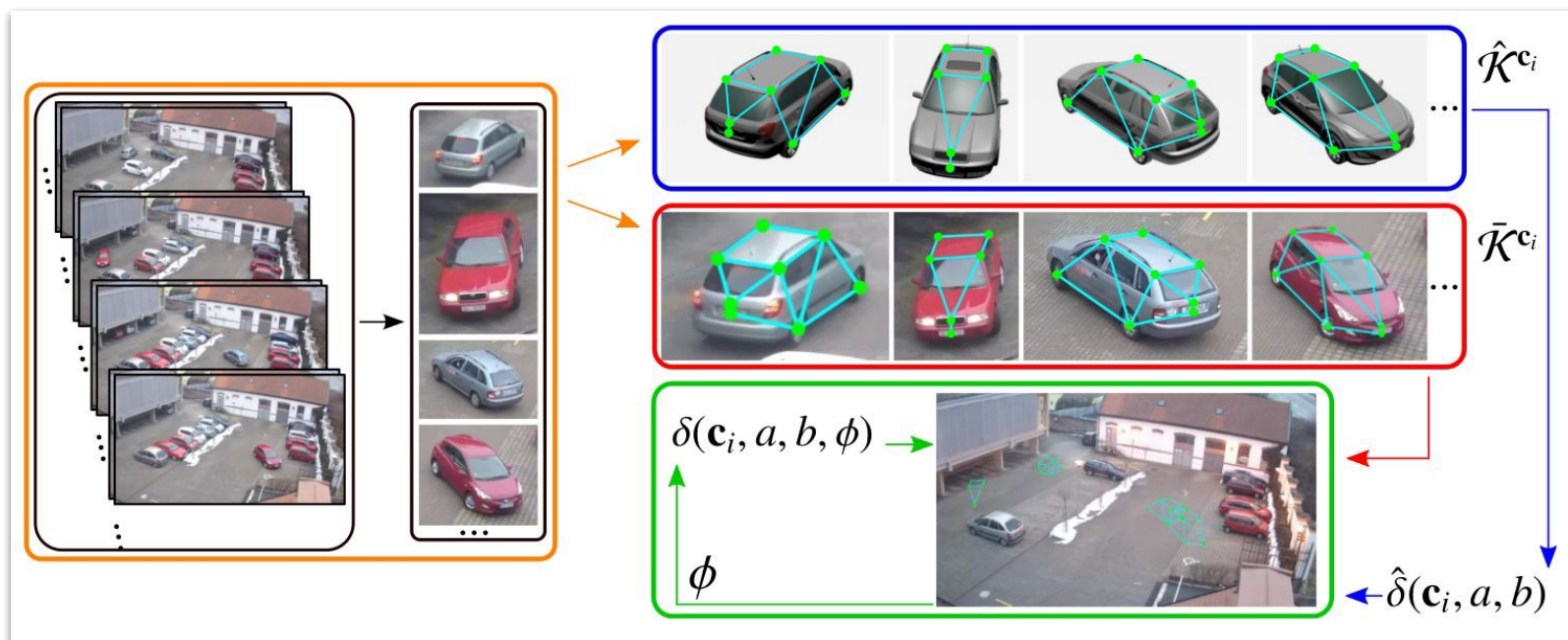
Works in linear motion case too!

Known **3D locations**
and **distances** for few
vehicle types



Detected landmarks

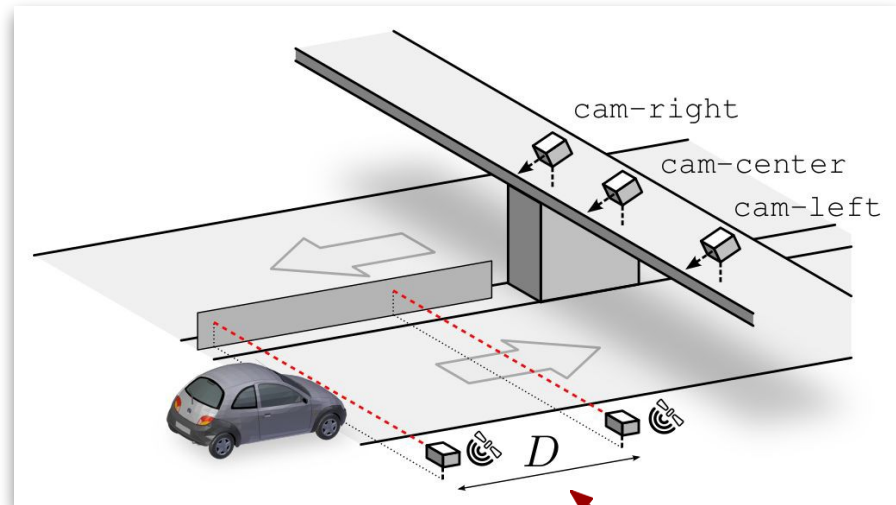




Optimization of calibration

Evaluation of speed measurement

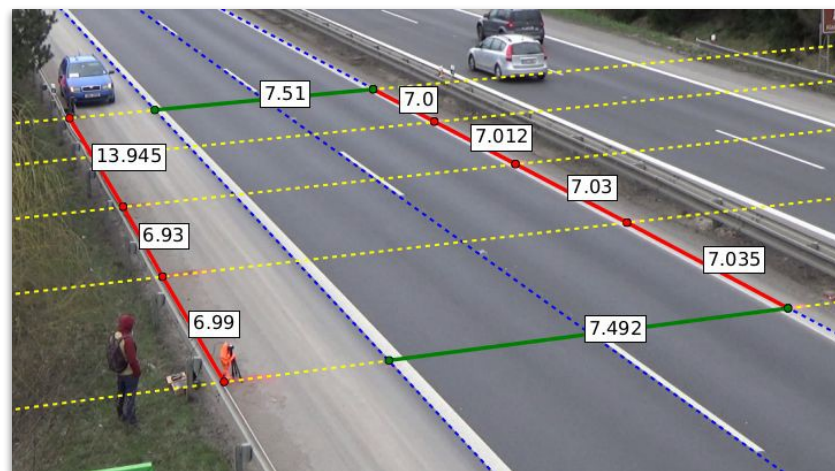
- There are absolutely no reliable public data for evaluation
- So we decided to record our own dataset - **BrnoCompSpeed**



LIDAR gates for ground
truth acquisition

BrnoCompSpeed dataset

- Overview camera scenario, linear motion
- **18 of Full HD videos** (approx. 1h each)
- 6 sessions, 3 cameras
- Manually measured distances in scene
- **LIDAR gates** for ground truth speed acquisition
- **> 20K** measured vehicles
- **Freely available for non commercial purposes**



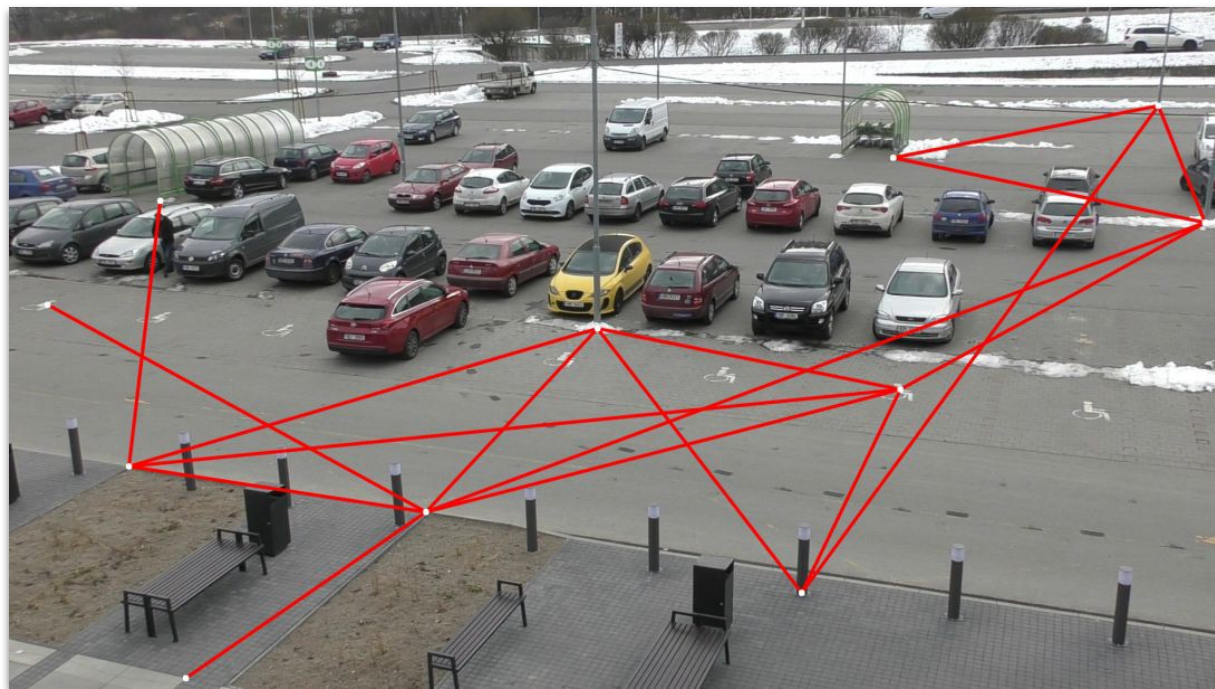
BrnoCarPark dataset

- **Free movement** of cars on parkinglots
- **2 locations**, multiple views
- Total **46h** of FullHDvideo
- Calibration only, no speed measurement
- Measured distances in scene for reference calibration



BrnoCarPark Dataset

- Example of measured distances



Future

- Speed measurement from observation of license plates (we need new dataset)
- 3D reconstruction of cars for better calibration
- Improvements in license plate reading in hard conditions
- Faster detection of license plates, cars, etc.
- Reliable re-identification of cars
- Embedded processing - put things in a device like NVidia Jetson
- ...

Thank you

<https://medusa.fit.vutbr.cz/traffic>

Publications

- BARTL Vojtech, ŠPAŇHEL Jakub, DOBES Petr, JURÁNEK Roman, HEROUT Adam. Automatic **Camera Calibration by Landmarks on Rigid Objects**. Computer Vision and Image Understanding (underreview)
- SOCHOR Jakub, JURÁNEK Roman, ŠPAŇHEL Jakub, MARŠÍK Lukáš, ŠIROKÝ Adam, HEROUT Adam a ZEMČÍK Pavel. **Comprehensive Data Set for Automatic Single Camera Visual Speed Measurement**. IEEE Transactions on Intelligent Transportation Systems. 2018, roč. 2018, č. 99, s. 1-11. ISSN 1524-9050.
- SOCHOR Jakub, JURÁNEK Roman a HEROUT Adam. **Traffic Surveillance Camera Calibration by 3D Model Bounding Box Alignment for Accurate Vehicle Speed Measurement**. Computer Vision and Image Understanding. 2017, roč. 2017, č. 161, s. 87-98. ISSN 1077-3142.
- DUBSKÁ Markéta, HEROUT Adam, JURÁNEK Roman a SOCHOR Jakub. **Fully Automatic Roadside Camera Calibration for Traffic Surveillance**. IEEE Transactions on Intelligent Transportation Systems. 2014, roč. 2014, č. 1, s. 1-10. ISSN 1524-9050.
- DUBSKÁ Markéta, SOCHOR Jakub a HEROUT Adam. **Automatic Camera Calibration for Traffic Understanding**. In: Proceedings of BMVC 2014. Nottingham: The British Machine Vision Association and Society for Pattern Recognition, 2014, s. 1-10. ISBN 1-901725-49-9.

EMBEDDED VISION TREND AND A REVOLUTIONARY CAMERA SERIES

Michael Ross ¹

¹ Allied Vision Technology

3rd INTERNATIONAL CONFERENCE

3D MEASUREMENT AND IMAGING

*MODERN CONTACTLESS MEASUREMENTS
IN INDUSTRIAL PRACTICE*



EMBEDDED VISION TREND
AND A REVOLUTIONARY CAMERA SERIES

Michael Ross, Sales Development Manager EMEA

TOPICS

- Embedded Vision – definition, goal and challenges
- A new approach with ALVIUM technology
- The ALVIUM product line as a game changer

Embedded Vision – Definition, goal and challenges

DEFINITION EMBEDDED SYSTEM

A dedicated and specialized computing system (HW + SW)
Carries out a single or a few dedicated task(s)

Dedicated
HW & SW

+

Dedicated Task(s)

DEFINITION EMBEDDED VISION SYSTEM

Allied Vision definition of Embedded Vision:
Embedded System + Computer Vision

Embedded Vision

Dedicated
HW & SW

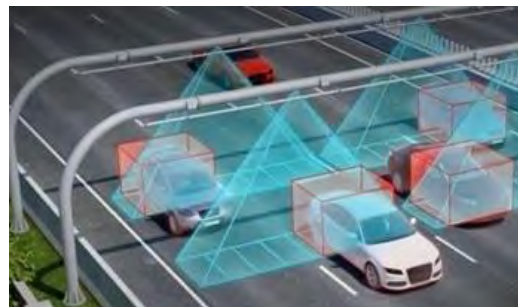
+

Dedicated **Vision**
Task

APPLICATIONS EXAMPLES



Source: www.zeiss.com



Source: www.azosensors.com



Source: www.intense.de



Source: www.coherentnews.com

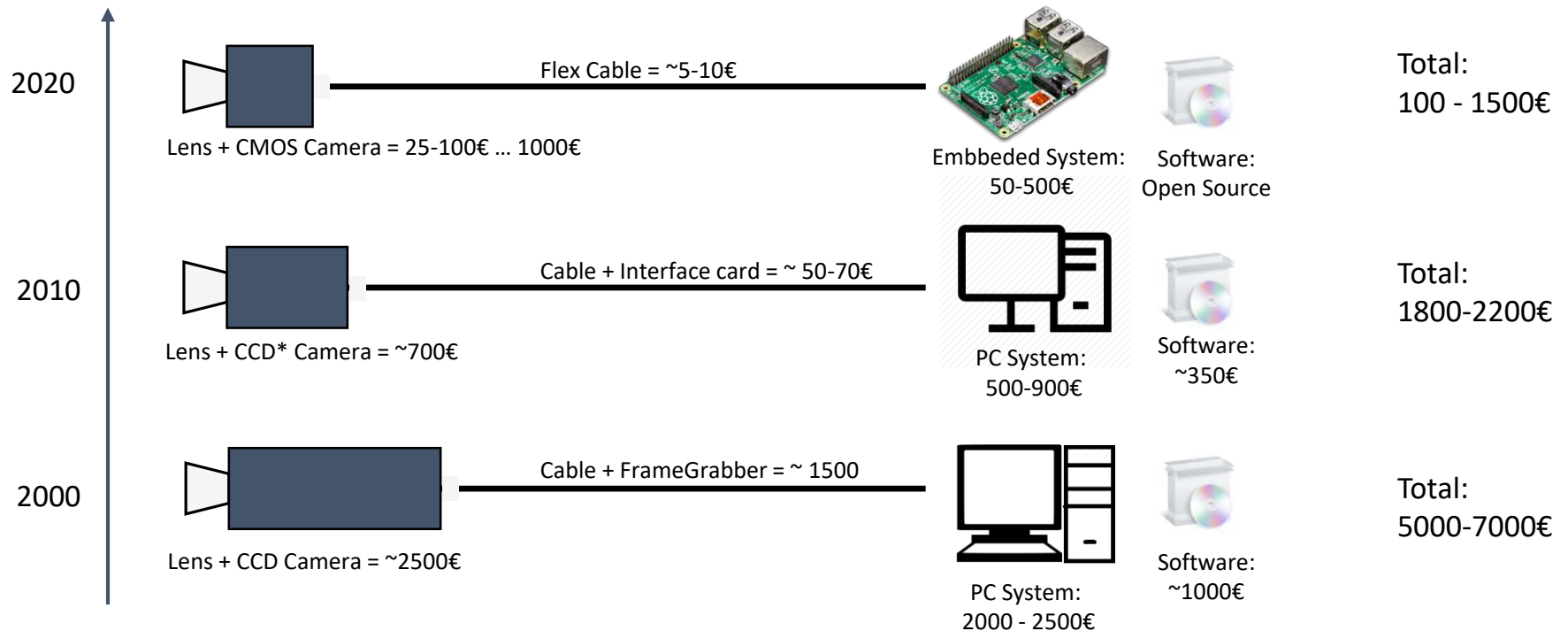
EMBEDDED SYSTEM VS. PC BASED SYSTEM

Embedded
System

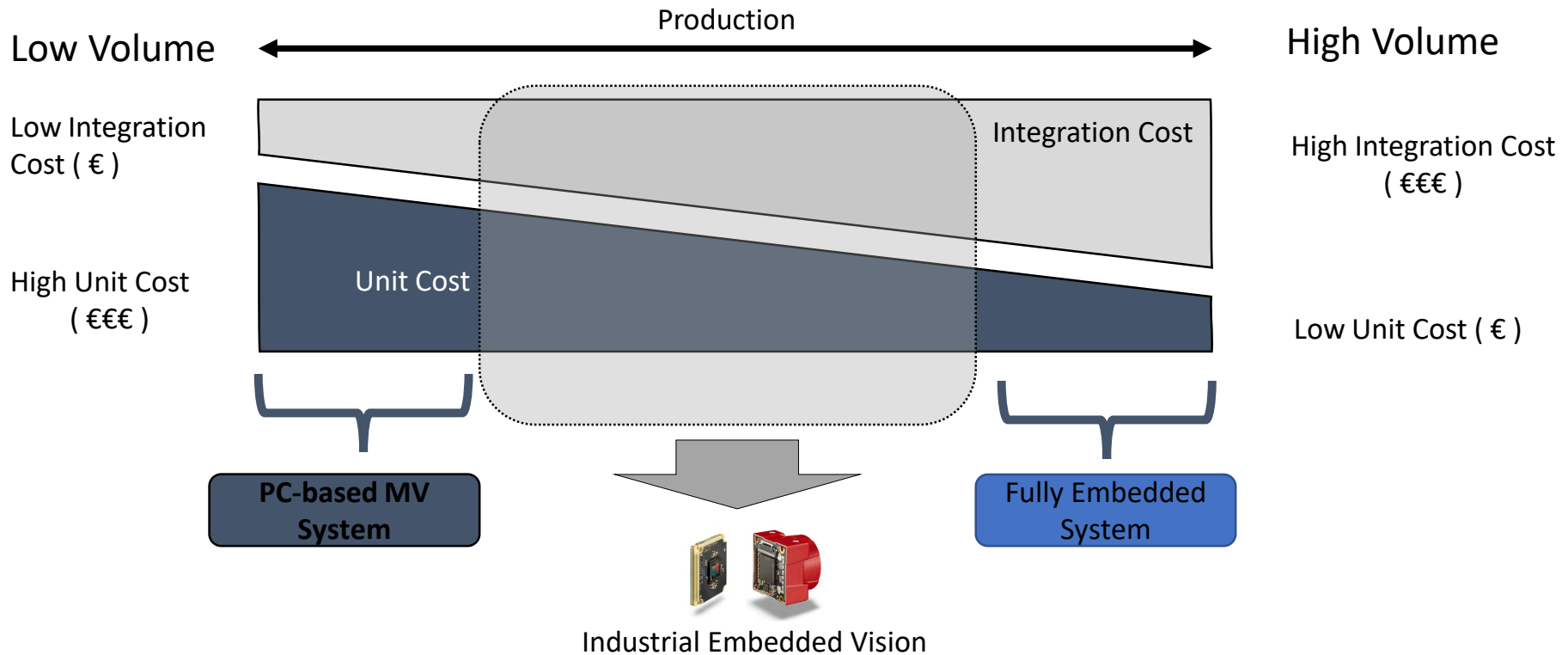
PC-based System

Size and Weight	Low	High
Power Consumption	Low	irrelevant
Expansion/Changes	No	flexible
System Environment	flexible	static

PRICE EROSION



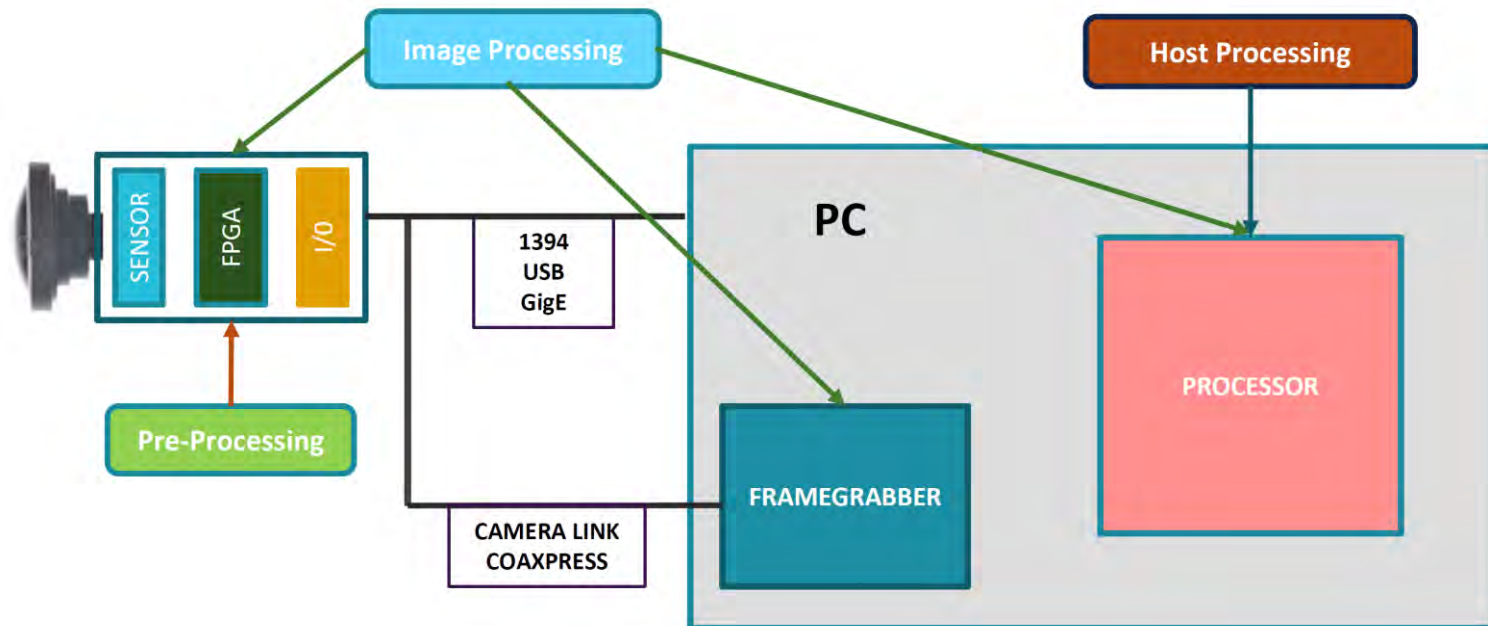
UNIT COSTS VS. DESIGN COSTS



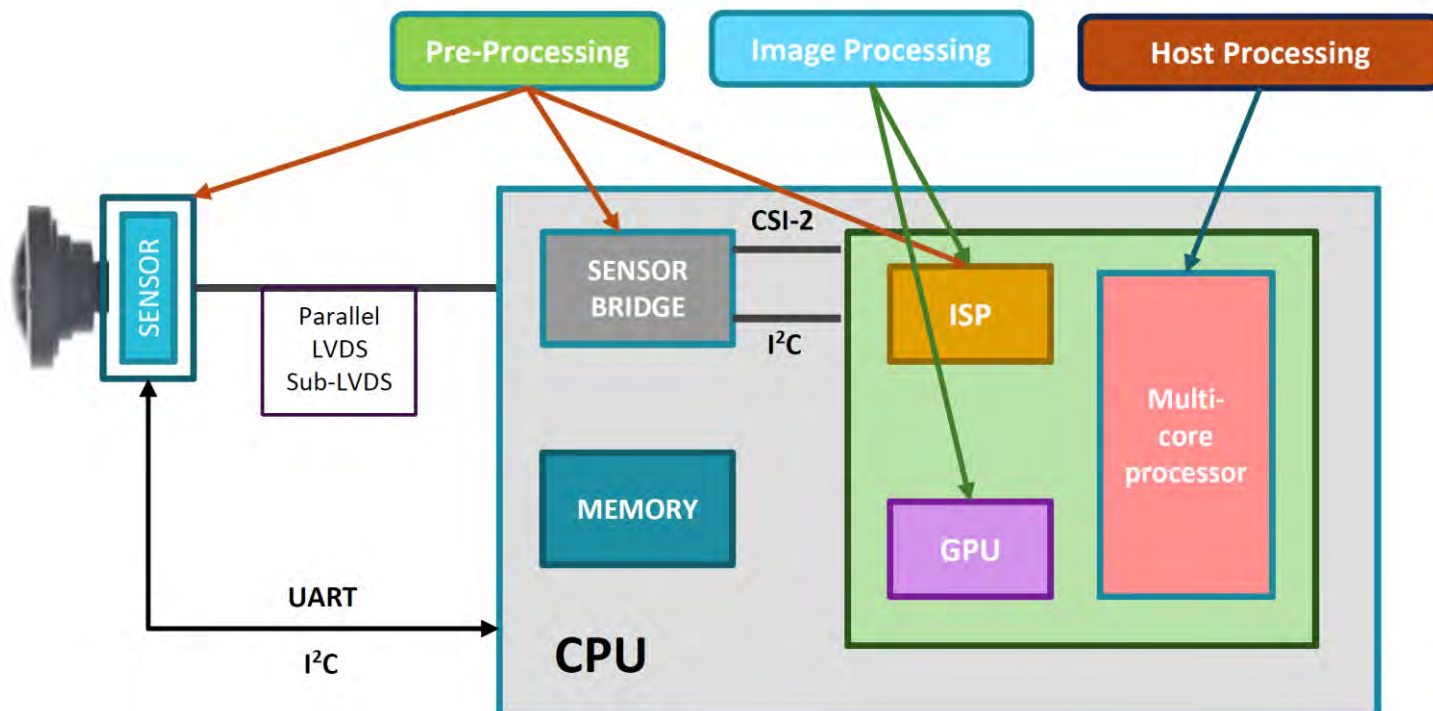
A new approach with ALVIUM technology



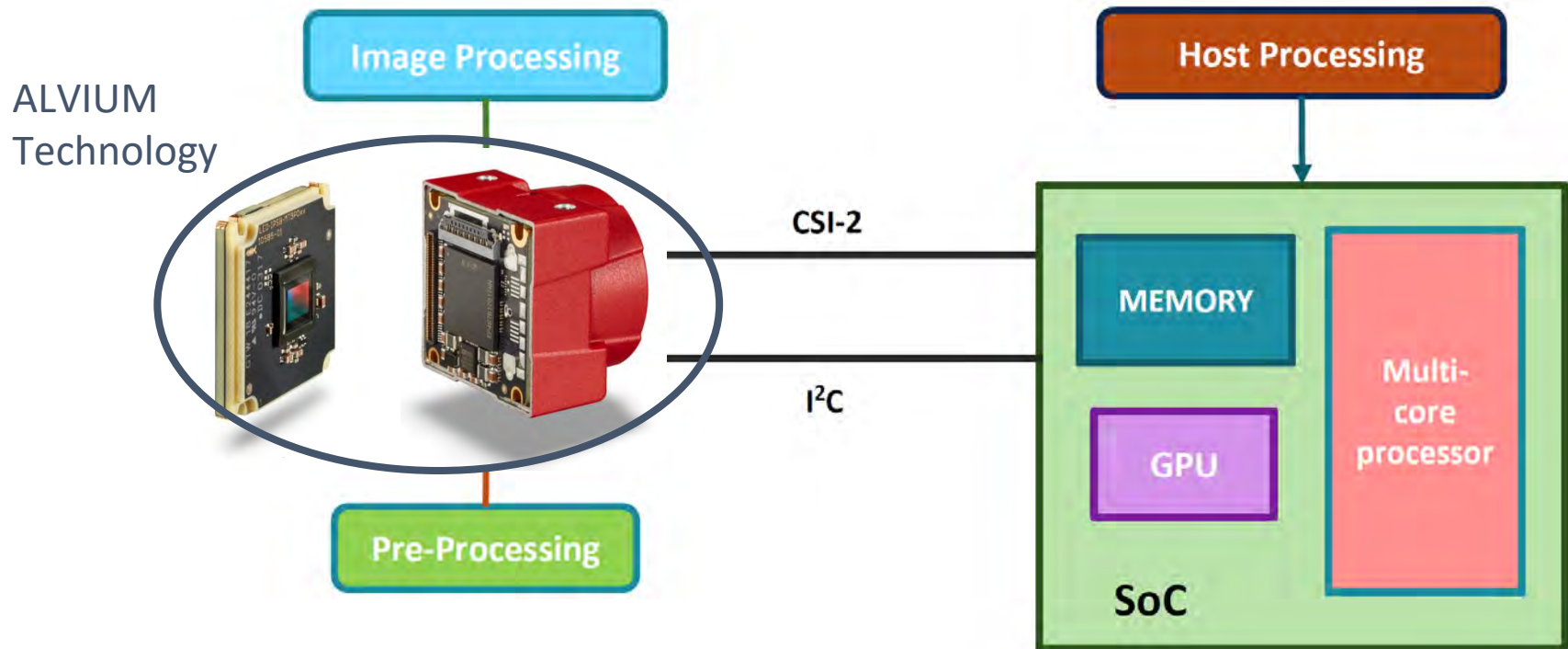
TYPICAL MACHINE VISION ARCHITECTURE



CONSUMER EMBEDDED VISION ARCHITECTURE



INDUSTRIAL EMBEDDED VISION ARCHITECTURE



WHAT IS ALVIUM TECHNOLOGY

ALVIUM Technology

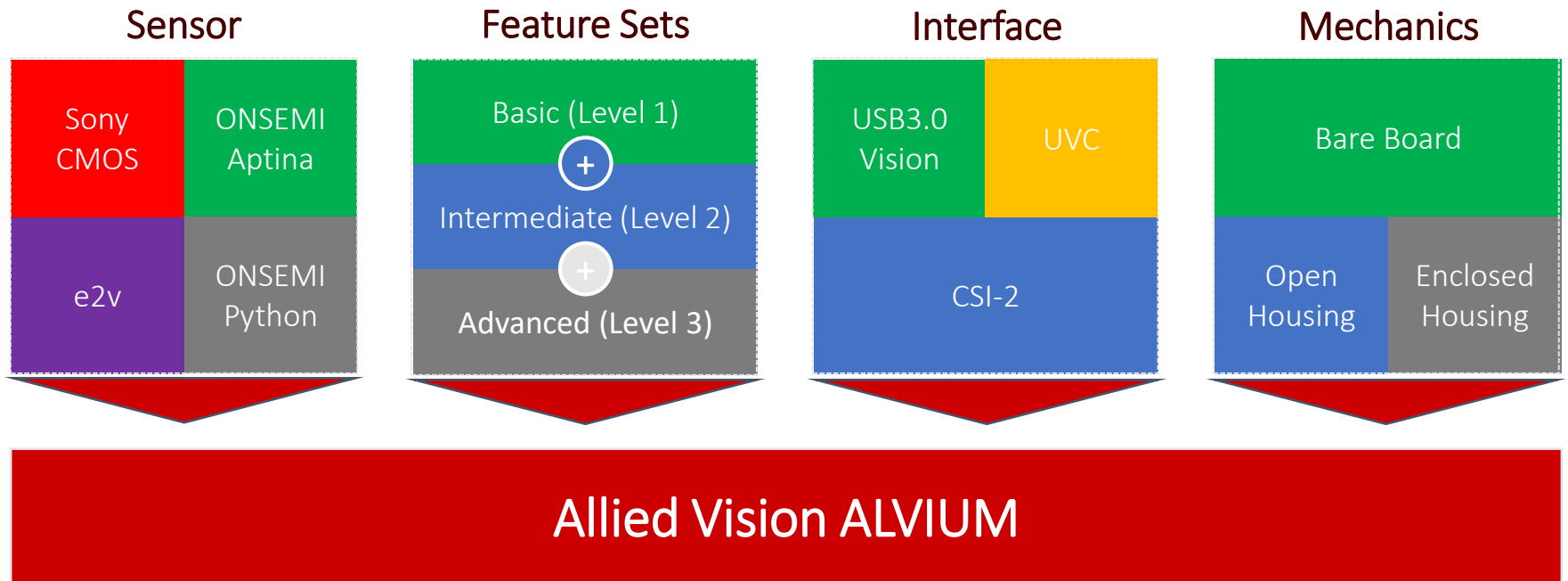
- // Over 25 years of Machine Vision experience in one single chip
- // Self-developed Vision Processor with integrated Image Processing Library
- // Unreached 90 features from nice image capability to advanced functionality
- // Integrated host interfaces MIPI CSI-2 D-PHY TX and USB3.1 Gen 1



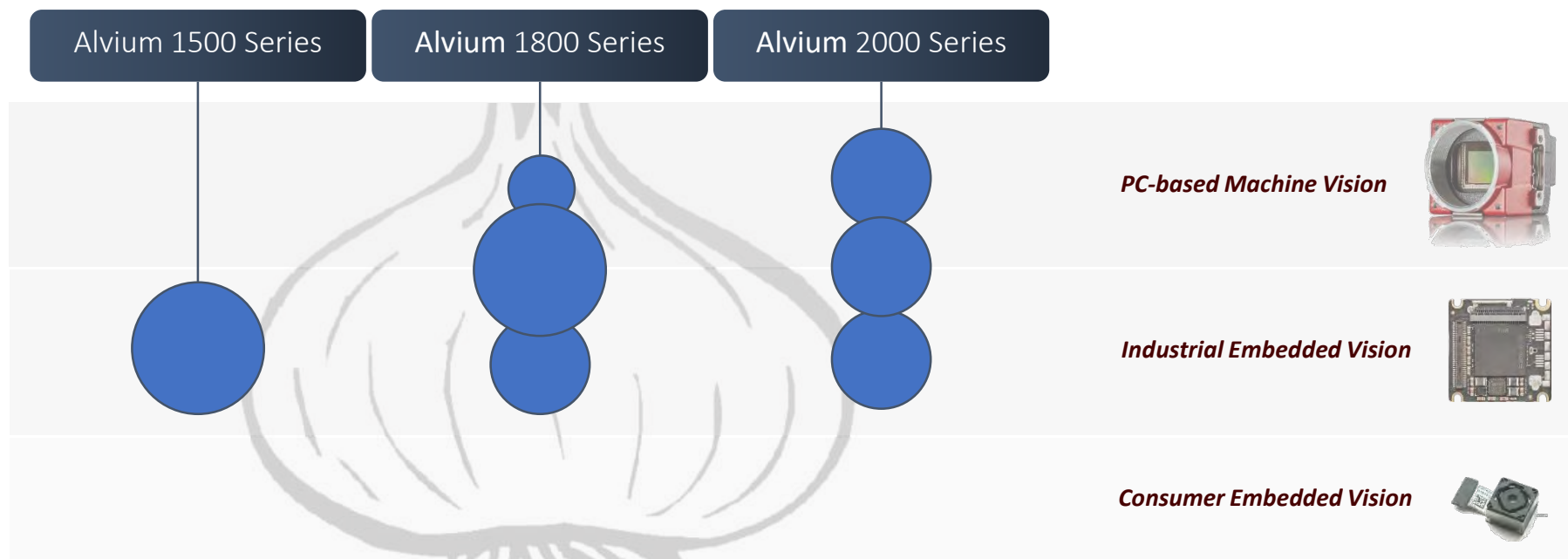
The ALVIUM product line as a game changer



ALVIUM PRODUCT LINE AT ONE GLANCE



ALVIUM POSITIONING IN TERMS OF HORIZONTAL TECHNOLOGY



PRODUCT PROFILE: ALVIUM 1500 SERIES

Alvium 1500 Series

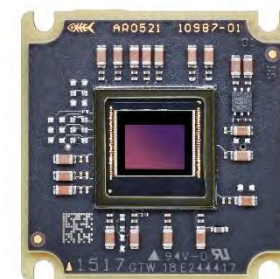
- // Within the **Alvium 1500 Series**, it is all about EASY VISION for Embedded Vision
- // Broad range of **MIPI CSI-2** and **UVC compliant USB3** cameras
- // **V4L2, GStreamer, UVC Standard API or Direct Register Access**
- // **Basic (Level I) on-board image processing**
- // Easy sensor evaluation via UVC, final development with MIPI cameras
- // Broad driver support with **i.MX6, i.MX8, TX1/TX2 and Xavier**
- // Various housing and broad sensor options



PRODUCT PROFILE: ALVIUM 1800 SERIES

Alvium 1800 Series

- // Within the **Alvium 1800 Series**, it is all about BRIDGING EV and MV
- // Broad range of **MIPI Vision** and **USB3 Vision** cameras
- // **Vimba SDK or Third Party Software**
- // **Intermediate (Level II) on-board image processing** beyond V4L2 and UVC
- // **GeniCam Standard Compatibility** with MIPI and USB3 Transport Layer
- // Broad driver support with **i.MX6, i.MX8, TX1/TX2 and Xavier**
- // Various housing and broad sensor options



PRODUCT PROFILE: ALVIUM 1800 SERIES

Alvium 2000 Series

- // Within the **Alvium 2000 Series**, it is all about expert image processing for EV and MV
- // Broad range of **MIPI Vision**, **USB3 Vision** and **GigE Vision** cameras
- // **Vimba SDK** or **Third Party Software**
- // **Advanced (Level III) on-board image processing**
- // **GeniCam Standard Compatibility** with MIPI, USB3 and GigE Transport Layer
- // Broad driver support with **i.MX6**, **i.MX8**, **TX1/TX2** and **Xavier**
- // Various housing and broad sensor options



CSI-2 DRIVER ENVIRONMENT

- NXP i.MX6
- NXP i.MX8
- Jetson TX1
- Jetson TX2
- Jetson Xavier



WELCOME TO VISION SHOW STUTTGART (NOV. 06 – 08, 2018)



Thank you very much!

Michael Ross

Sales Development Manager EMEA

michael.ross@alliedvision.com

Allied Vision Technologies GmbH

www.alliedvision.com

THE JOURNEY TO NANO WORLD USING ELECTRON MICROSCOPY SCANNING

Ing. Hana Tesařová, PhD. ¹

¹TESCAN ORSAY HOLDING, a.s.

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. During the workshop the presentation will contain several sections: In the first, the history and working principle of the Scanning electron microscopy will be introduced. Then, the comparison of the optical, scanning and transmission electron microscopy will be shown as well as application for all of this fields. The last part will highlight the latest progress in the 3D application field.

MEDZINÁRODNÁ KONFERENCIA

3D MERANIE A ZOBRAZOVANIE

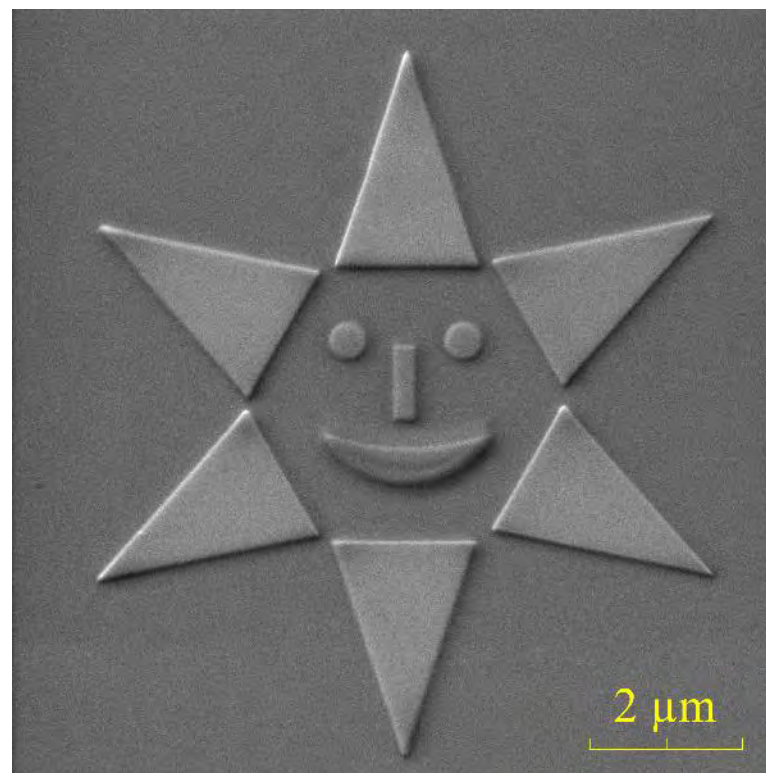
3. ročník

*MODERNÉ BEZKONTAKTNÉ MERANIA
V PRIEMYSELNEJ PRAXI*

CESTA DO NANOSVĚTA
POMOCÍ SKENOVACÍ
ELEKTRONOVÉ MIKROSKOPIE

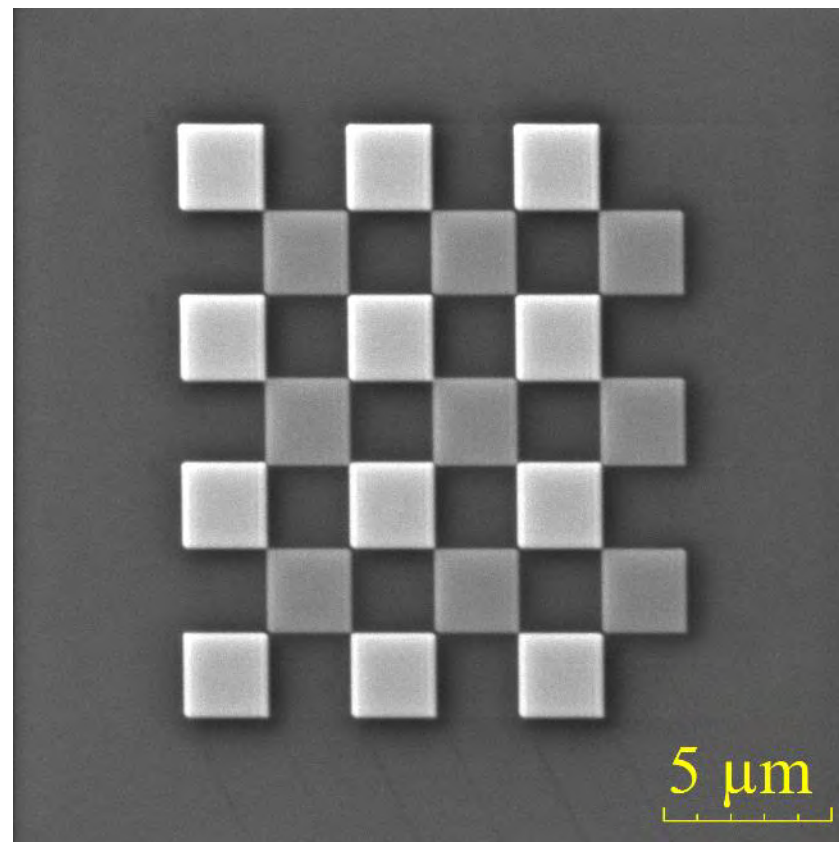
Hana Tesařová, Ph.D.

- TESCOAN
- PROČ ELEKTRONOVÁ MIKROSKOPIE
- HISTORIE ELEKTRONOVÉ MIKROSKOPIE
- SROVNÁNÍ OPTICKÉ A ELEKTRONOVÉ MIKROSKOPIE
- PRINCIPY ELEKTRONOVÉ MIKROSKOPIE
- OBLASTI VYUŽITÍ



➤ **TESCAN**

- PROČ ELEKTRONOVÁ MIKROSKOPIE
- HISTORIE ELEKTRONOVÉ MIKROSKOPIE
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TESCAN

TESCAN ORSAY HOLDING
HQ



TESCAN BRNO
High-end R&D



TESCAN



• TESCO, s.r.o. established



• MIRA Schottky FE-SEM introduced

• Chinese branch established



• FERA3 and TIMA introduced
• 1000 SEM installed & ISO certification

• Merger of TESCO and ORSAY PHYSICS resulted in TESCO ORSAY HOLDING, a.s.
• TESCO-UK Ltd. established



• XEIA3 and Q-PHASE introduced

• TESCO Benelux + TESCO Do Brasil established



• S8000G introduced



• VEGA SEM introduced



• LYRA FIB-SEM introduced



• Acquisition of TESCO USA

• Third generation of TESCO SEMs introduced



• MIRA3 AMU introduced



• Acquisition of App Five

• GAIA3 and RISE introduced



• NEW UHR Series Triglav™

➤ TESCOAN

➤ **CO JE TO MIKROSKOPIE?**

➤ HISTORIE ELEKTRONOVÉ
MIKROSKOPIE

➤ SROVNÁNÍ OPTICKÉ A
ELEKTRONOVÉ MIKROSKOPIE

➤ PRINCIPY ELEKTRONOVÉ
MIKROSKOPIE

➤ OBLASTI VYUŽITÍ



CO JE TO MIKROSKOPIE?

- Mikroskopie je technická a vědecká disciplína zabývající se pozorováním věcí neviditelných okem



Okem



*Pomocí optického
mikroskopu*



*Pomocí elektronového
mikroskopu*





Okem

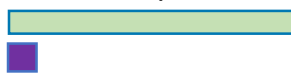
1 mm

1/4 mm (250 μm)

- Vlas
- Vlákno
- Tenká čára tužkou

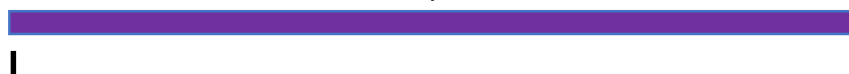


Mikroskopem

250 μm

1/1000 mm (1 μm)

- Struktura rostlin
- Živé buňky

Elektronovým mikroskopem

1 μm

1/1000 μm (1 nm)

- Nanostruktury polovodičů
- Mikropraskliny v materiálech
- Virus v živých vědách





10^0
1 m



10^1
10 m



10^2
100 m



10^3
1,000 m
1 km



10^6 m
1,000 km



10^8 m
100,000 km



10^{10} m
10,000,000 km



10^0
1 m



10^{-1}
0.1 m



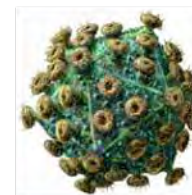
10^{-2}
0.01 m



10^{-3}
0.001 m
1 mm



10^{-6} m
0.000 001 m
1 μm

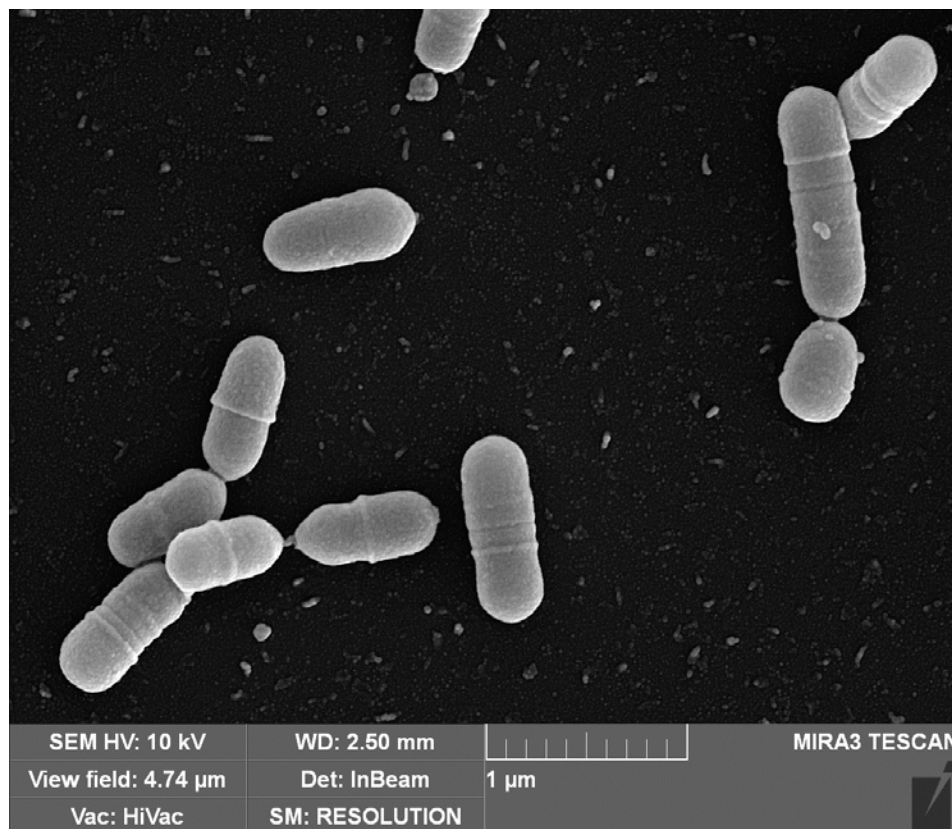


10^{-8} m
0.000 000 01 m



10^{-9} m
0,000000001m
1 nm³

- TESCAN
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- PRINCIPY ELEKTRONOVÉ MIKROSKOPIE
- OBLASTI VYUŽITÍ
- NENÍ MIKROSKOP JAKO MIKROSKOP



HISTORIE ELEKTRONOVÉ MIKROSKOPIE

- 1887 – objev elektronu (J.J. Thompson, Cambridge)
- 1924 – dualismus vln a částic (Louis de Broglie, Paříž)
- 1926 – první elektromagnetická čočka (Hans Busch, *Německo*)
- 1931 – prototyp transmisního elektronového mikroskopu – TEM (Ernst Ruska, Max Knoll, *Německo*)
- 1938 – první (komerční) rastrovací transmisní elektronový mikroskop – STEM (Manfred von Ardenne, Berlin, SIEMENS)
- 1942 – první rastrovací elektronový mikroskop – SEM (Vladimir Kosmich Zworykin, *USA*)
- **1950 – pokusné zařízení se dvěma magnetickými čočkami (Armin Delong)**
- **1951 – první komerčně dostupný československý mikroskop s označením Tesla BS 241 (TESLA Brno, A. Delong, V. Drahoš, Zobač)**
- 1986 – Ernst Ruska – Nobelova cena

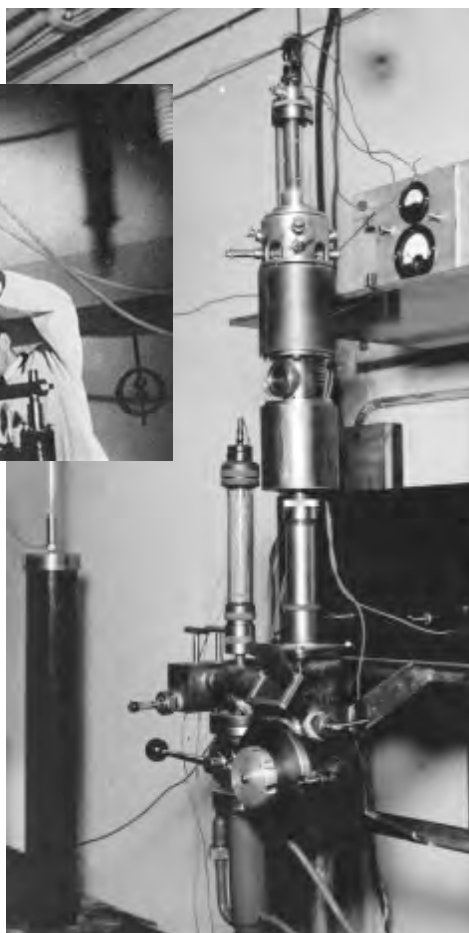
HISTORIE ELEKTRONOVÉ MIKROSKOPIE



TEM, E. Ruska (1933)



E. Ruska,
M. Knoll

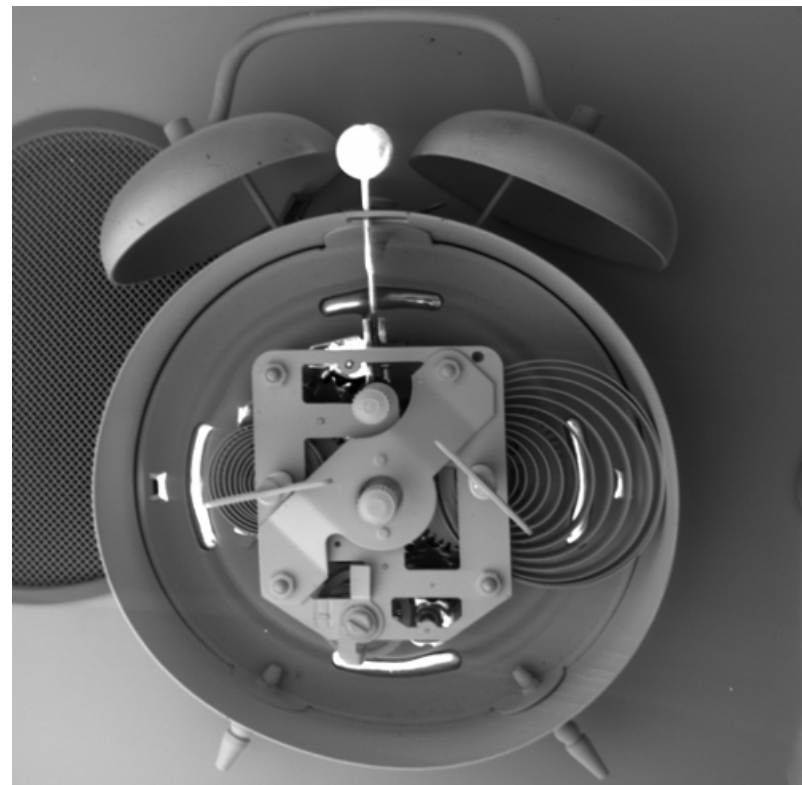


Pokusné zařízení



Tesla BS 241

- TESCAN
- CO JE TO MIKROSKOPIE?
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- **SROVNÁNÍ OPTICKÉ A
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OPTICKÁ VS ELEKTRONOVÁ MIKROSKOPIE

Elektronový mikroskop



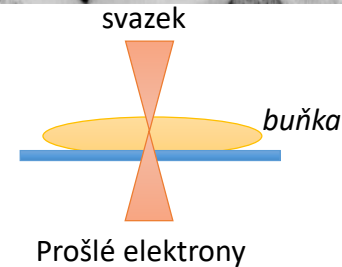
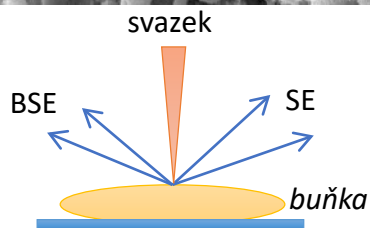
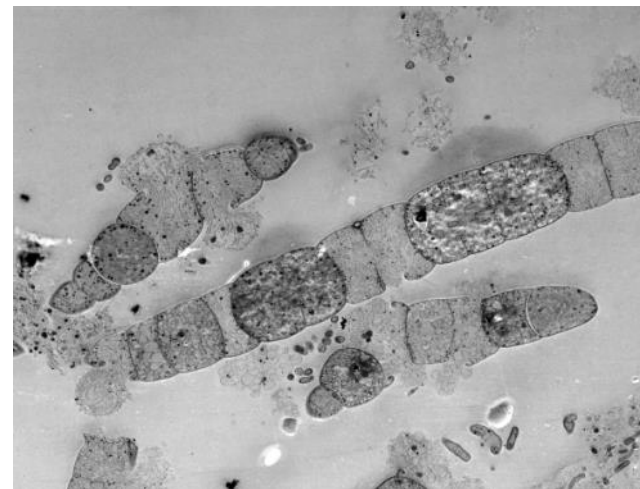
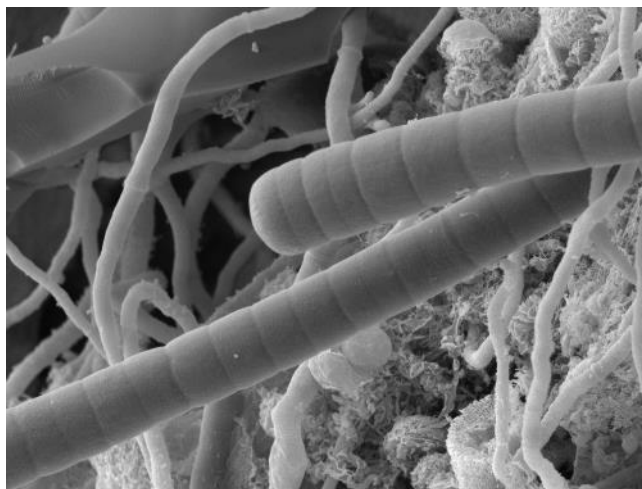
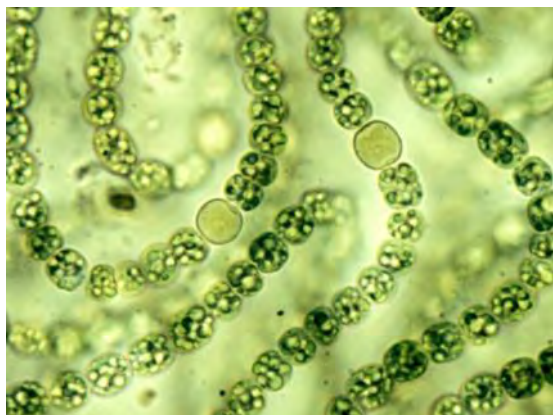
OPTICKÁ VS ELEKTRONOVÁ MIKROSKOPIE

➤ SINICE

Světelný mikroskop

SEM

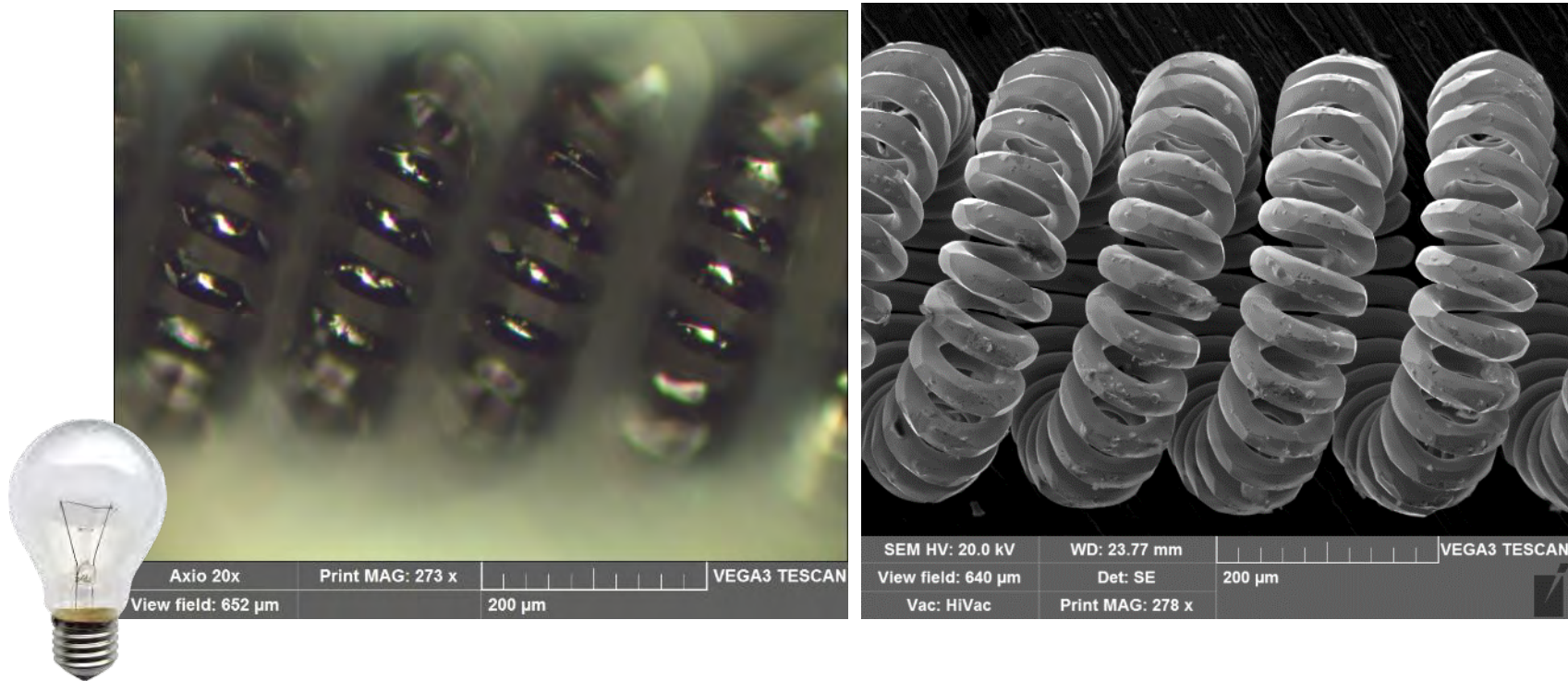
TEM



Williams, A. Mic. Phys., 2006

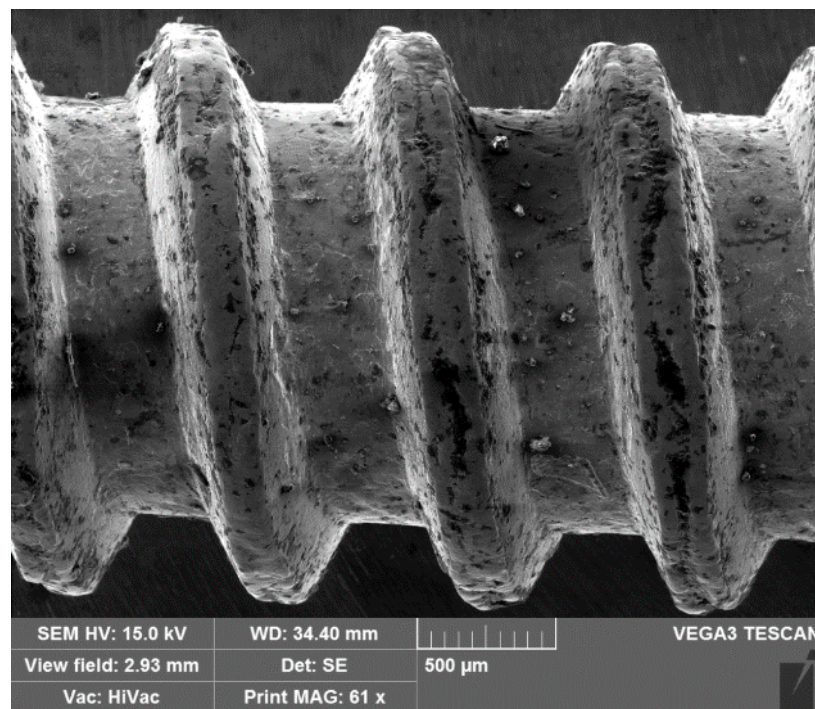
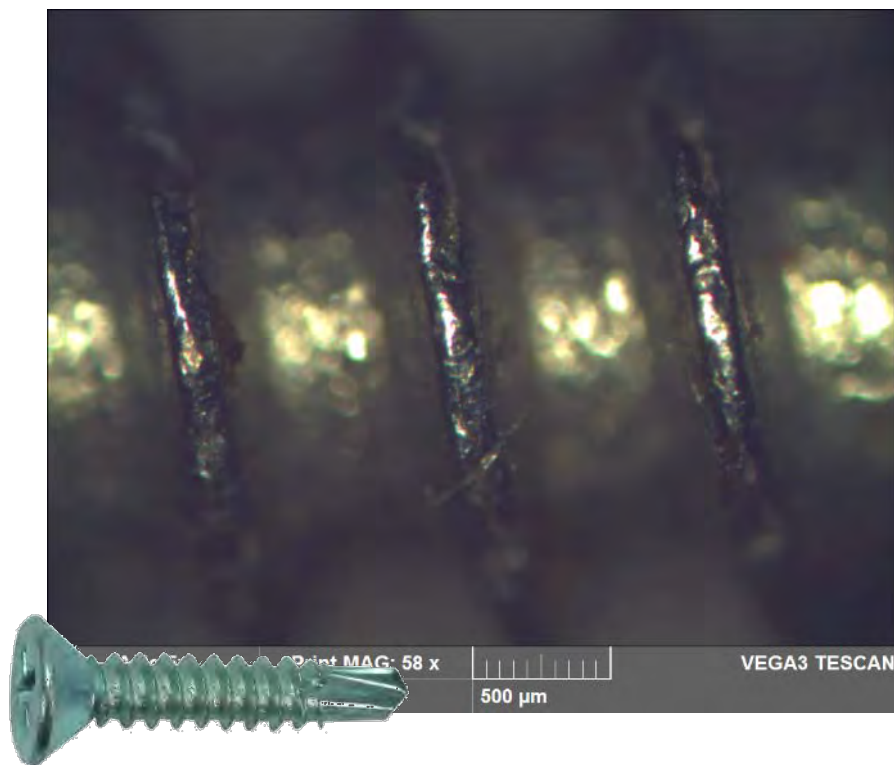
OPTICKÁ VS ELEKTRONOVÁ MIKROSKOPIE

➤ VLÁKNO ŽÁROVKY – VÝHODA HLOUBKY OSTROSTI

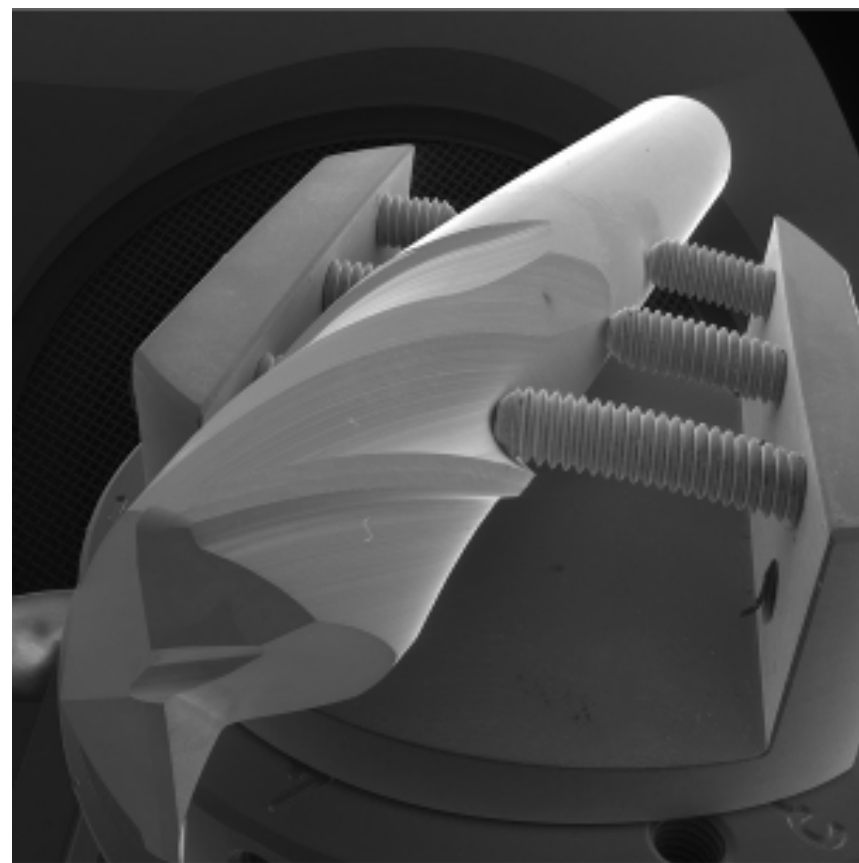


OPTICKÁ VS ELEKTRONOVÁ MIKROSKOPIE

➤ ŠROUB – VÝHODA HLOUBKY OSTROSTI

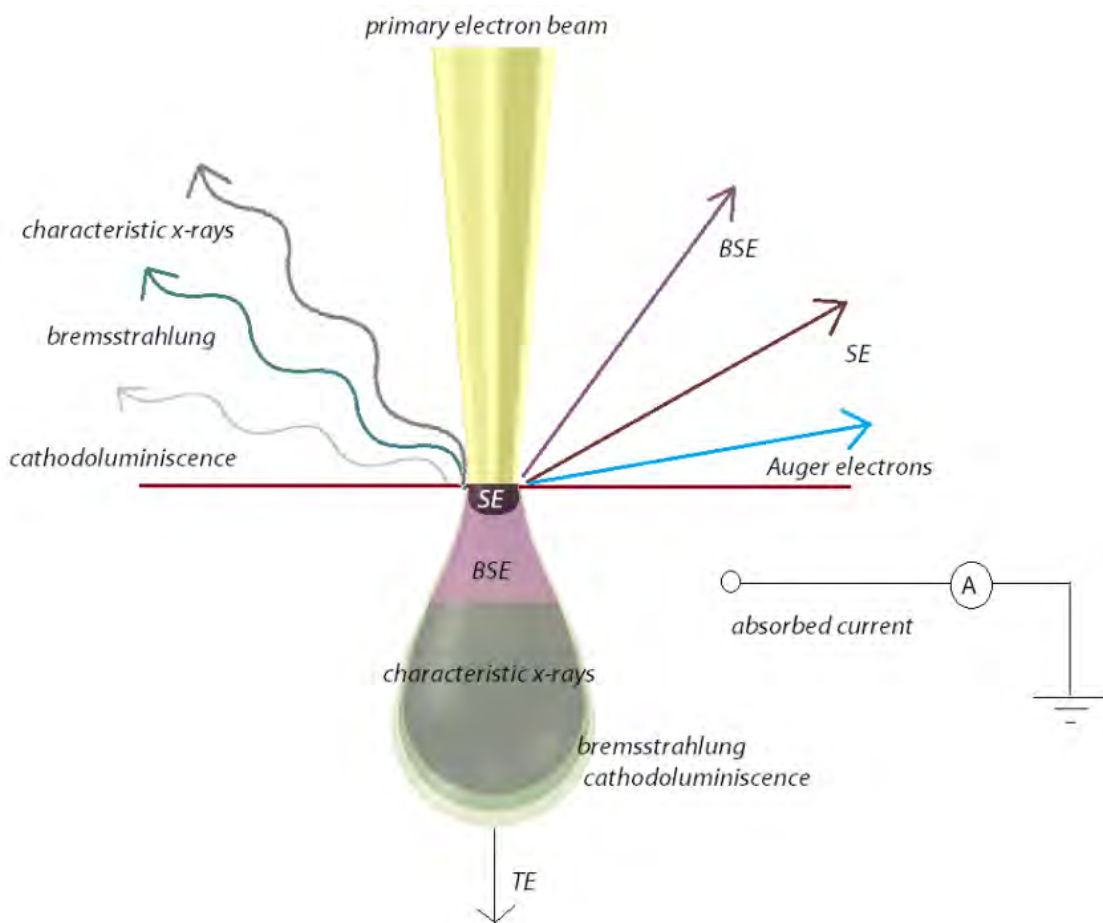


- TESCOAN
- CO JE TO MIKROSKOPIE?
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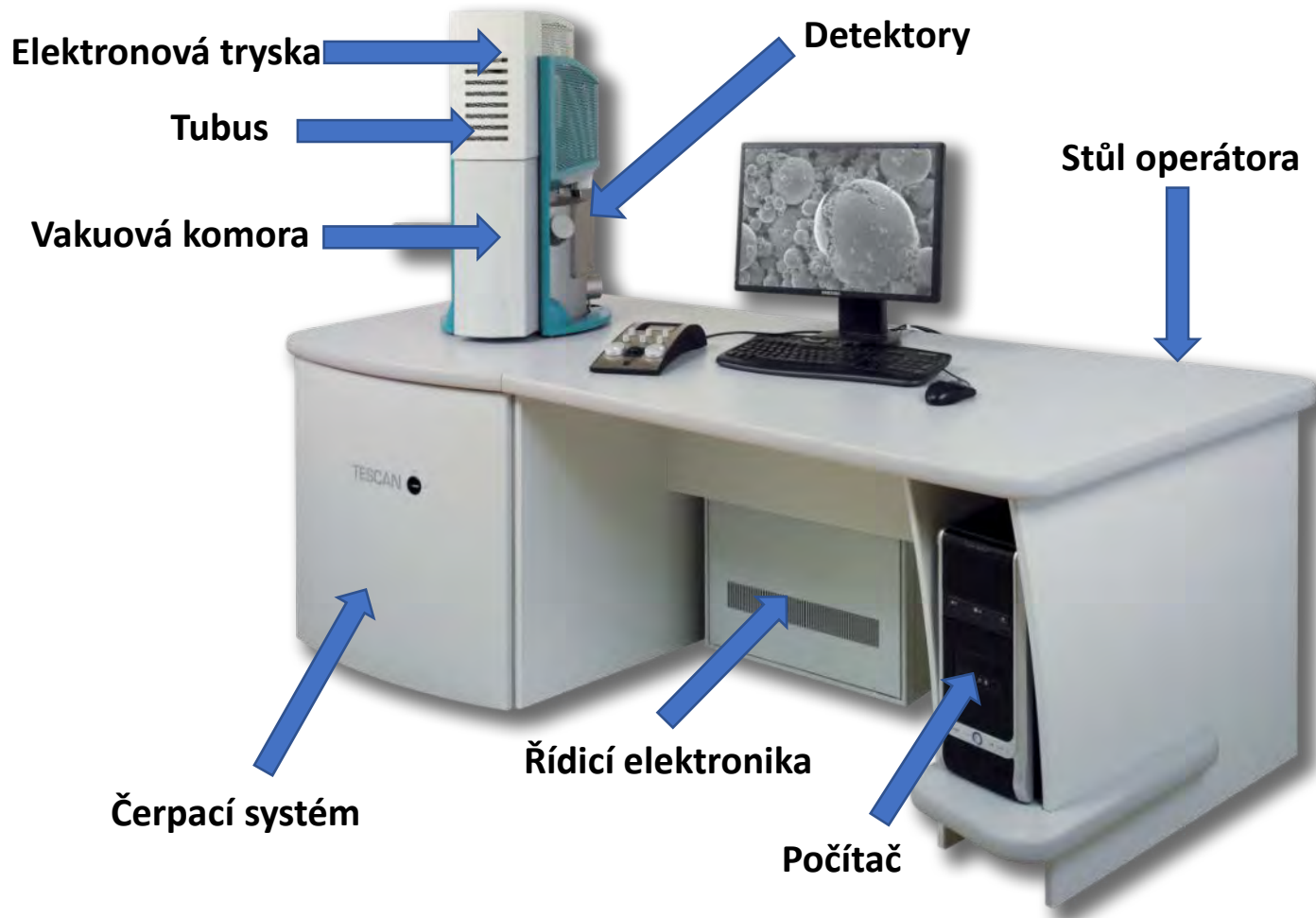


ELEKTRONOVÁ MIKROSKOPIE

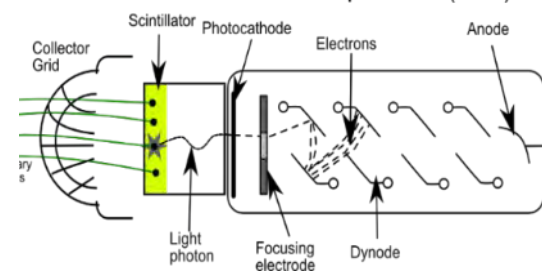
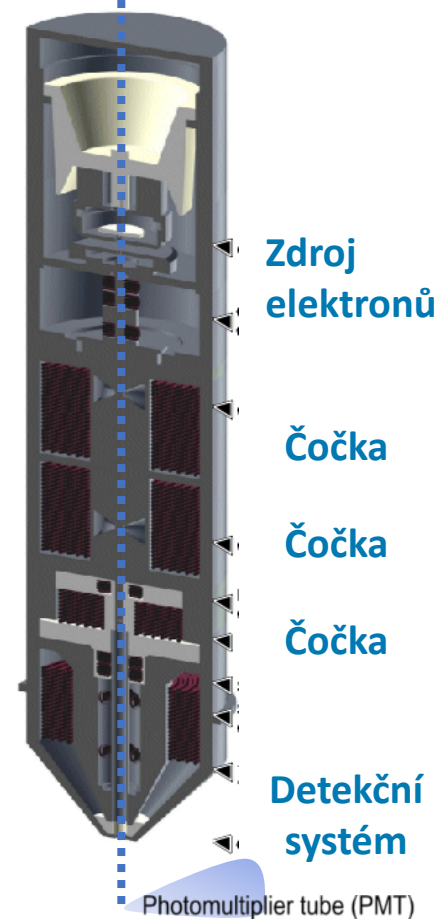
➤ INTERAKCE ČÁSTIC S PEVNOU LÁTKOU



ELEKTRONOVÁ MIKROSKOPIE



Optická osa



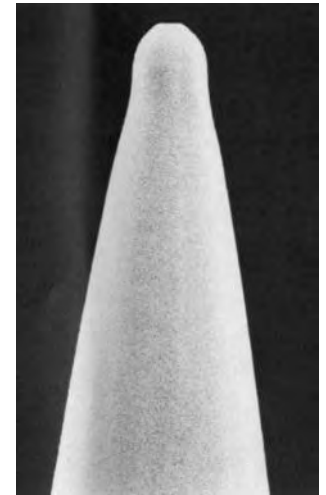
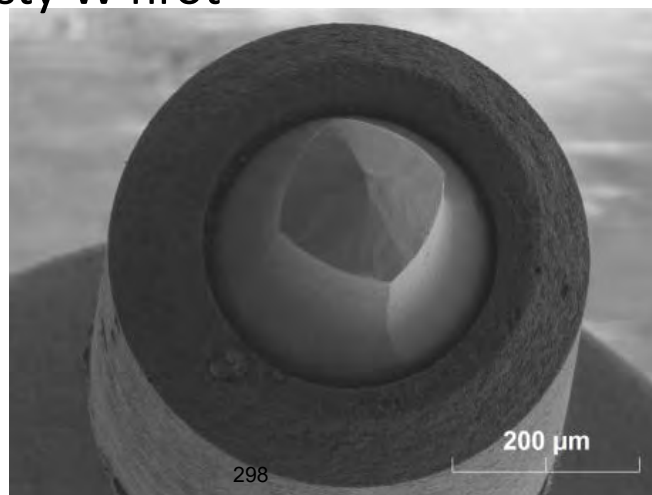
SEM TESCOAN VEGA3

➤ ZDROJ ELEKTRONŮ - ELEKTRONOVÁ TRYSKA

- Vygenerování svazku primárních elektronů
- Urychlení primárních elektronů
- Formování svazku přímo do tubusu

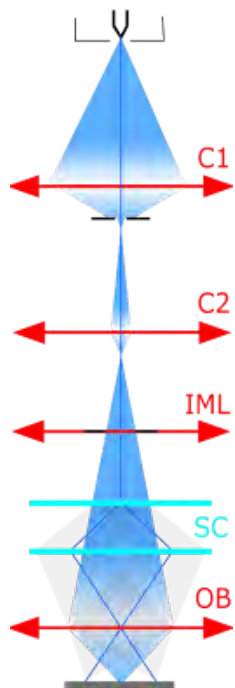
➤ TYPY ELEKTRONOVÝCH TRYSEK

- Termální emise – žhavené W vlákno, krystal LaB_6
- Schottkyho autoemisní katoda – žhavený W hrot s emisní vrstvou
- Studená emise – čistý W hrot

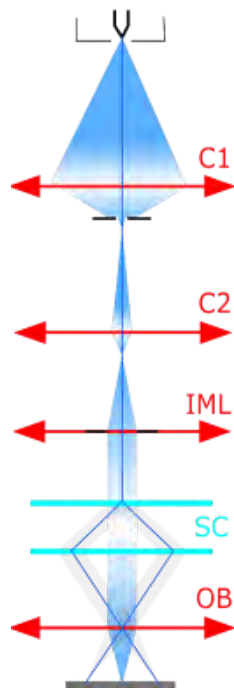


➤ ZOBRAZOVACÍ REŽIMY

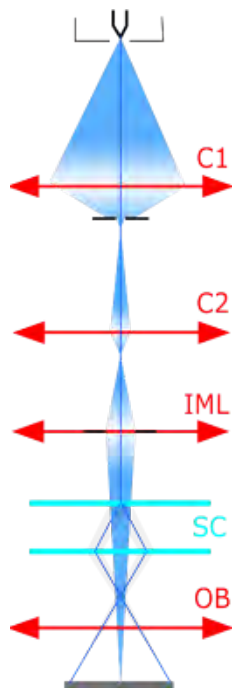
Resolution



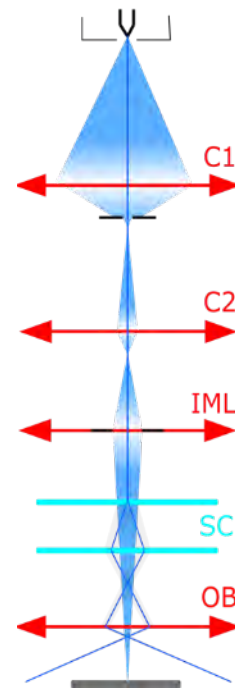
Depth



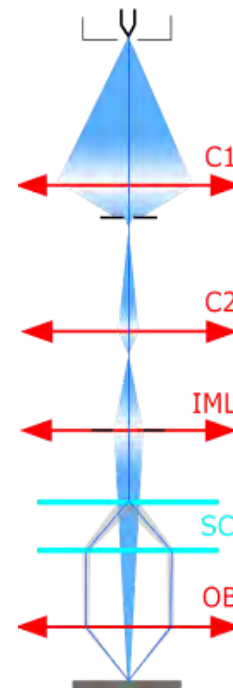
Field

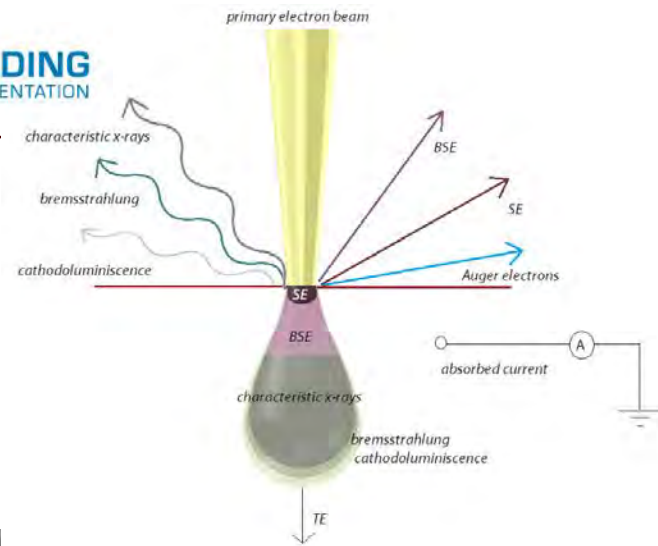


Wide Field



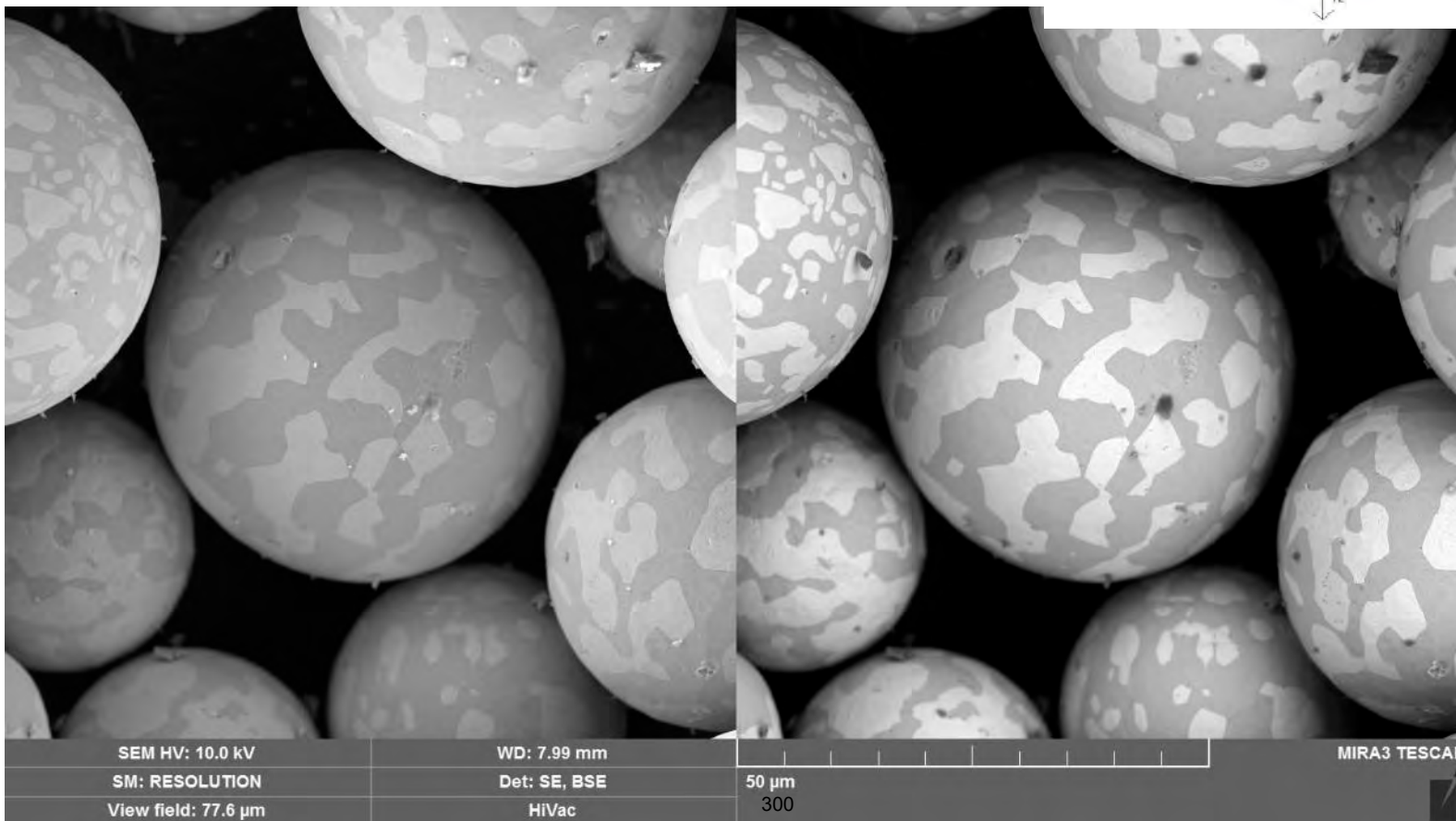
Channelling





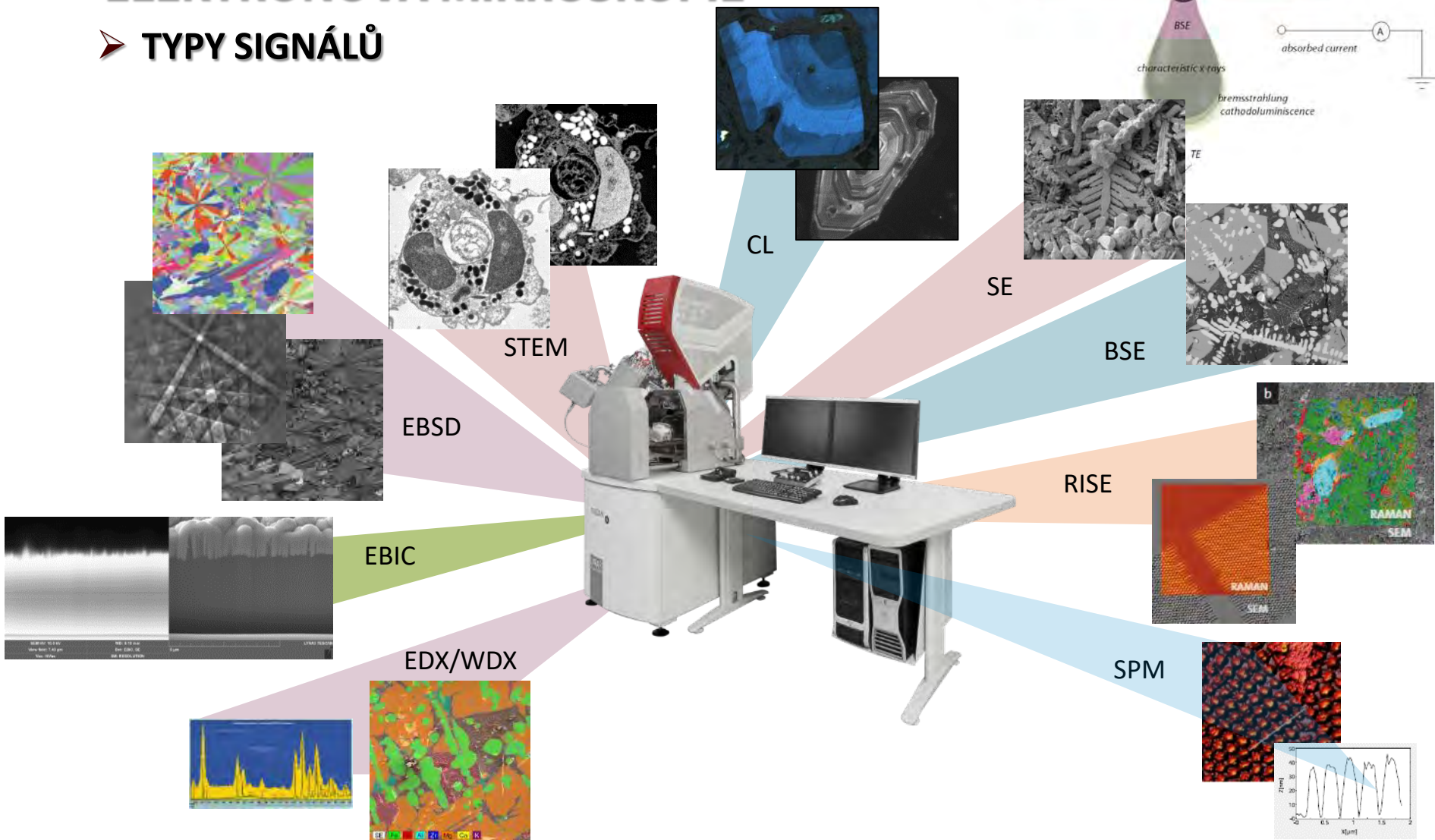
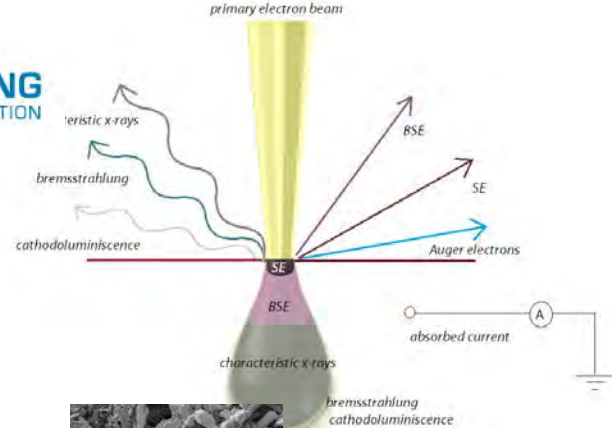
➤ TYPY SIGNÁLŮ

- Sekundární elektrony (SE)
- Zpětně-odražené elektrony (BSE)

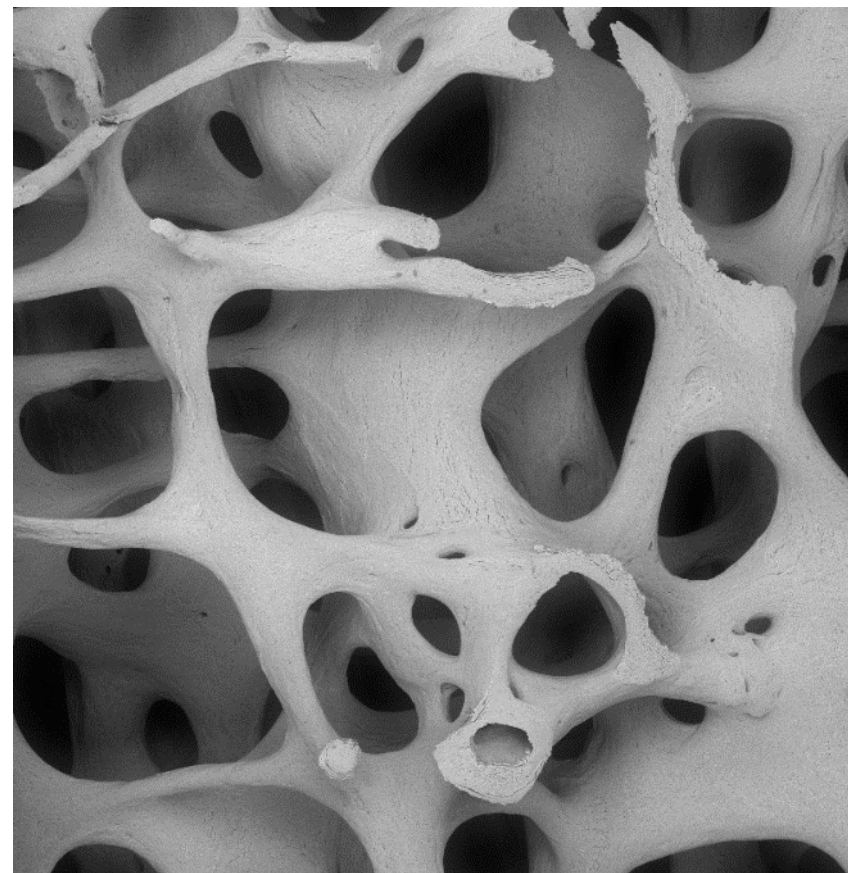


ELEKTRONOVÁ MIKROSKOPIE

➤ TYPY SIGNÁLŮ



- TESCOAN
- CO JE TO MIKROSKOPIE?
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- PRINCIPY ELEKTRONOVÉ MIKROSKOPIE
- **OBLASTI VYUŽITÍ**
- NENÍ MIKROSKOP JAKO MIKROSKOP





OBLAST VYUŽITÍ EM

➤ ZOBRAZOVÁNÍ – makrosvět

MŠICE



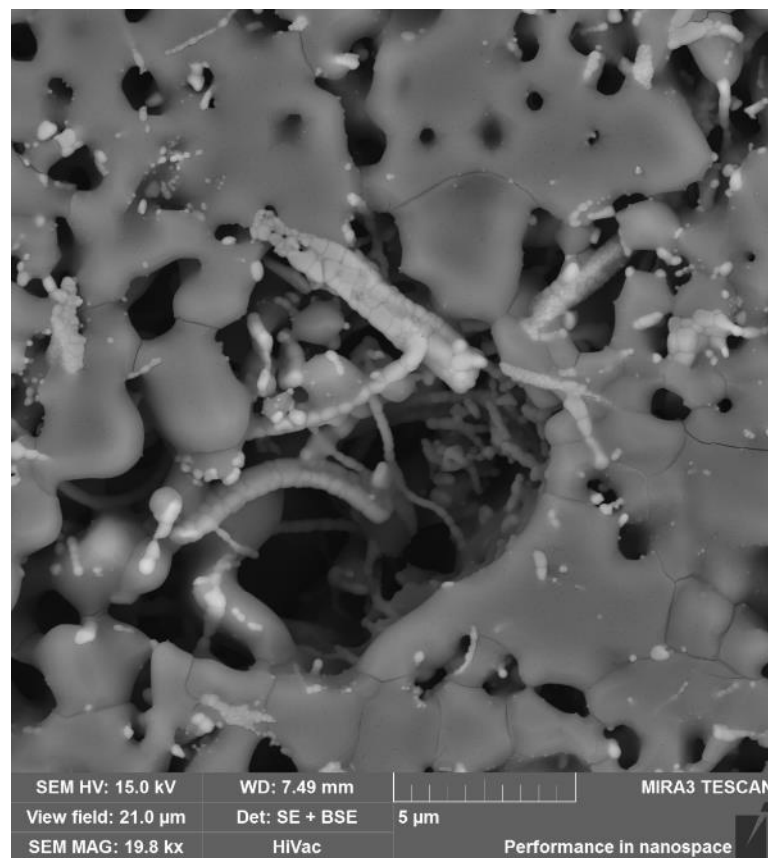
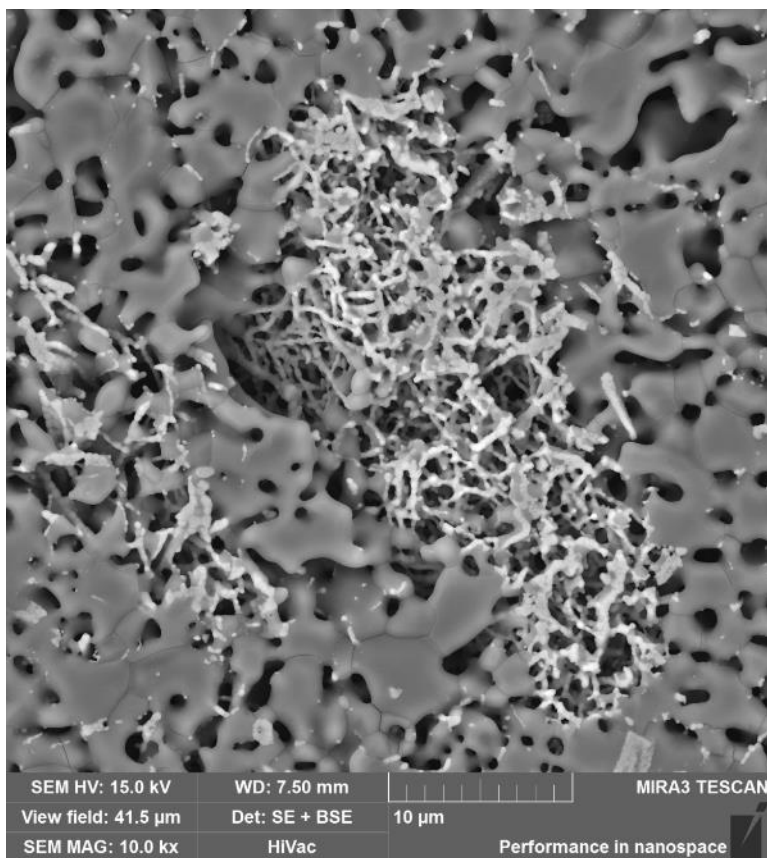
SLUNÉČKO SEDMITEČNÉ



OBLAST VYUŽITÍ EM

➤ ZOBRAZOVÁNÍ - mikrosvět

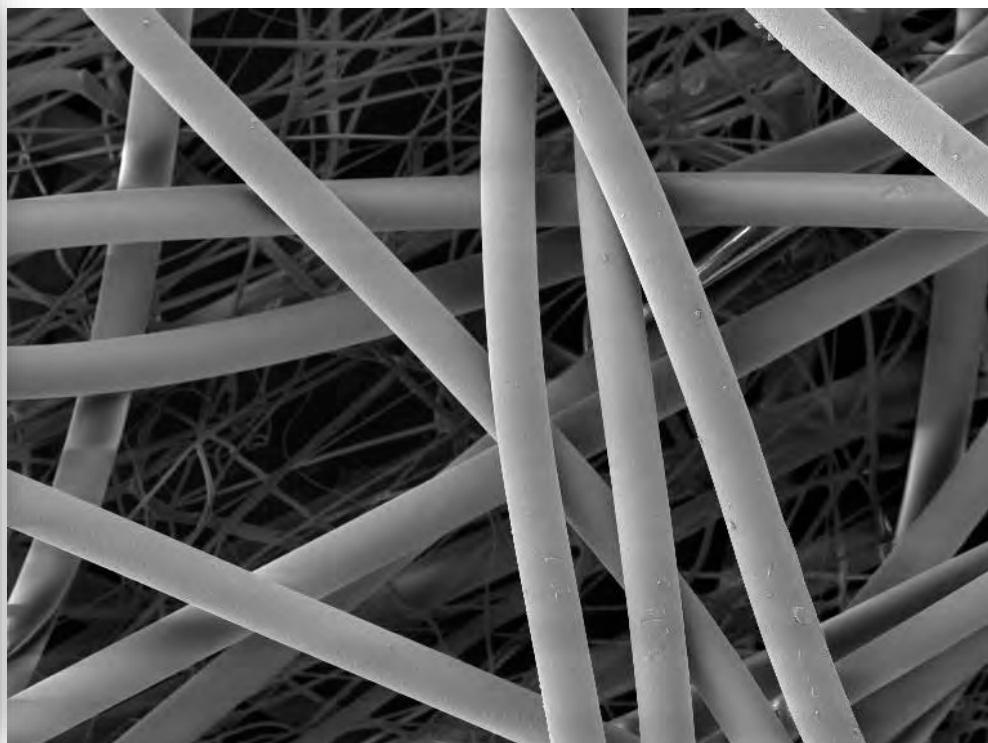
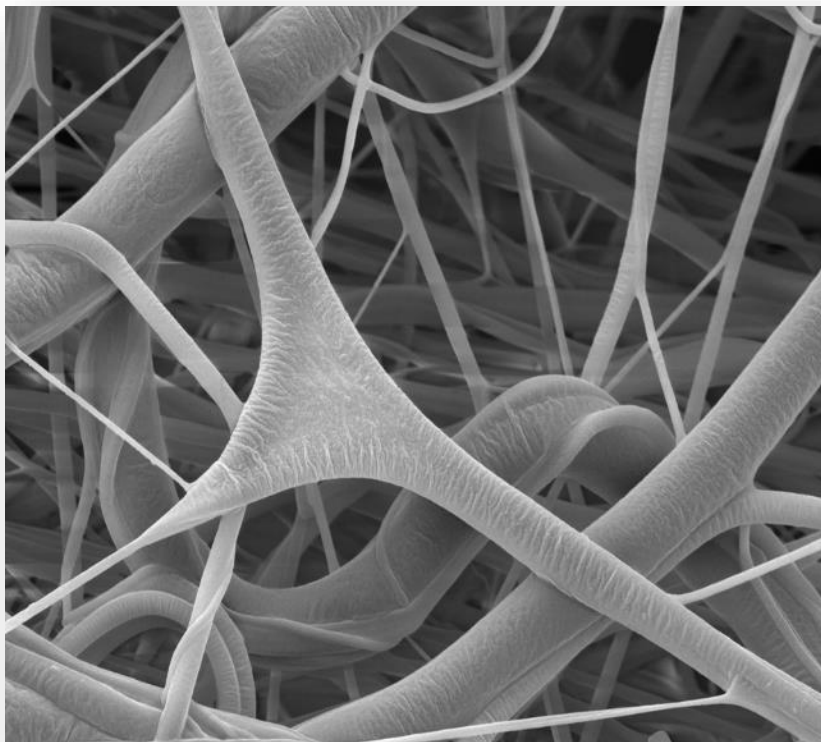
VLÁKNA V KONSTRUKČNÍCH MATERIÁLECH



OBLAST VYUŽITÍ EM

➤ ZOBRAZOVÁNÍ - mikrosvět

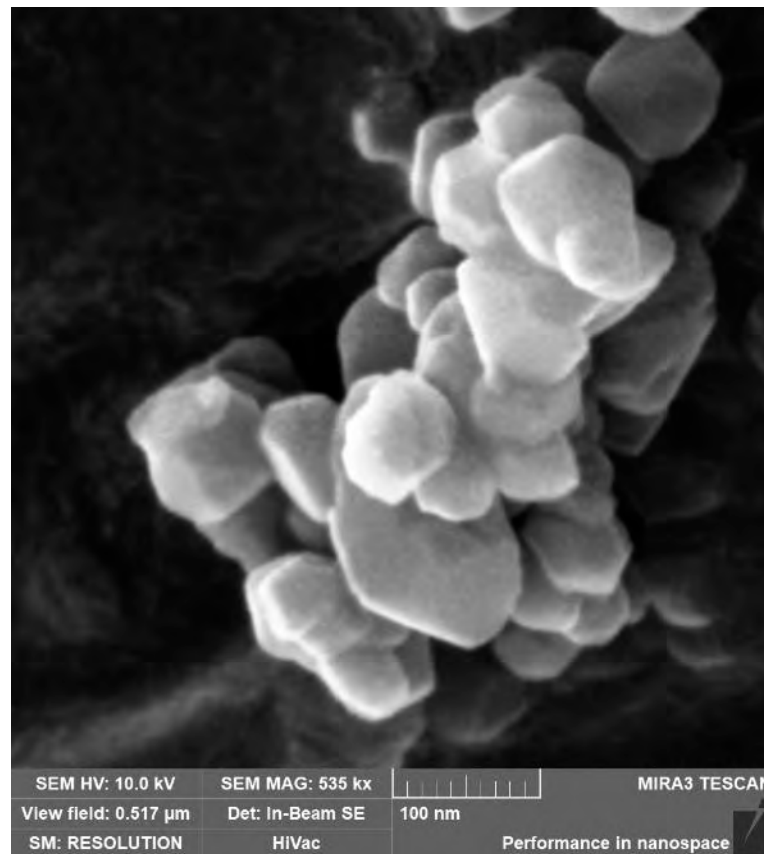
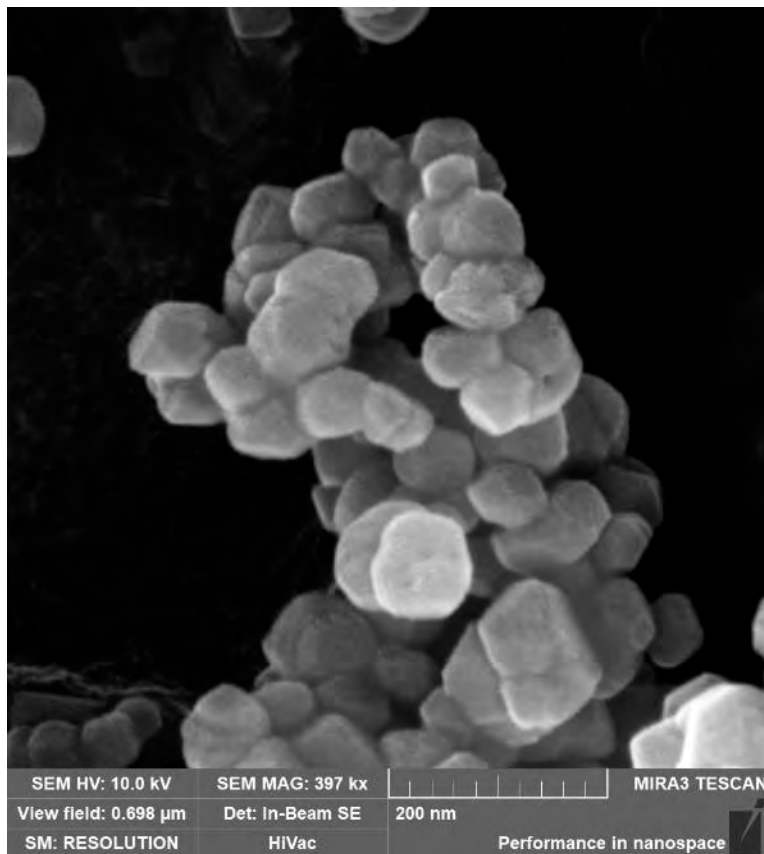
VLÁKNA



OBLAST VYUŽITÍ EM

➤ ZOBRAZOVÁNÍ - nanosvět

NANOČÁSTICE V BARVÁCH



OBLAST VYUŽITÍ EM

➤ ZOBRAZOVÁNÍ – HODNOCENÍ KONSTRUKČNÍCH MATERIÁLŮ

S.S. Schenectady (1942)



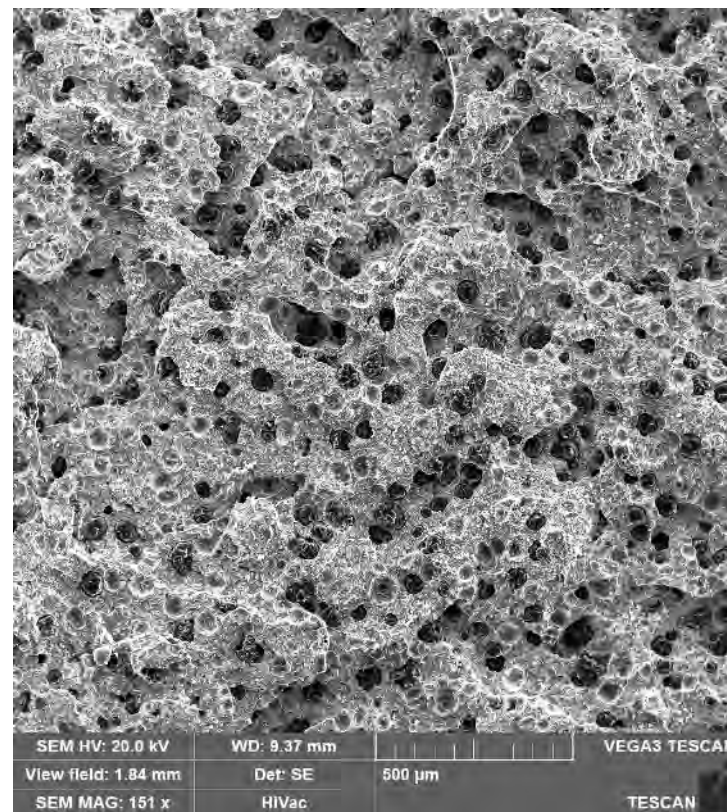
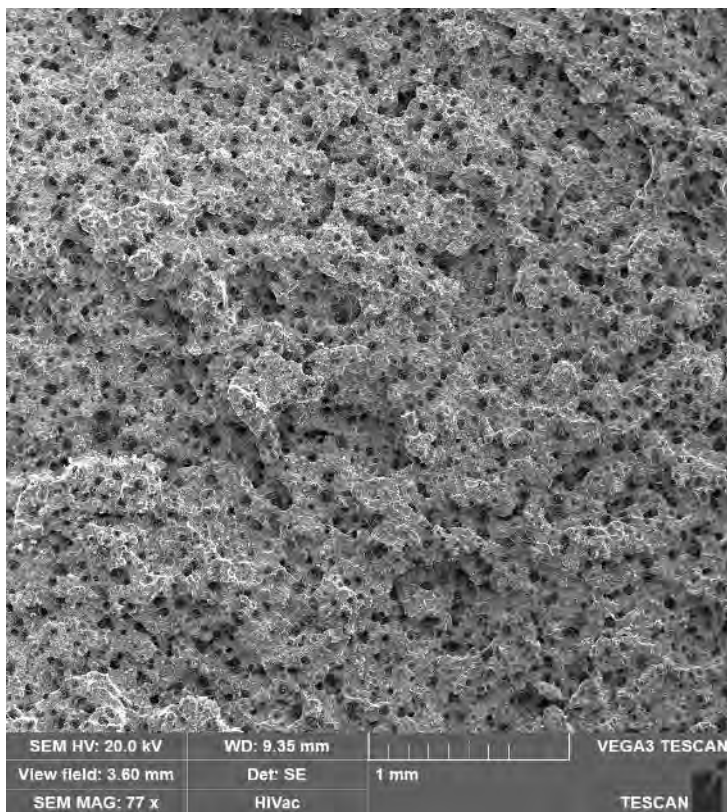
Nákladní loď (2017)



OBLAST VYUŽITÍ EM

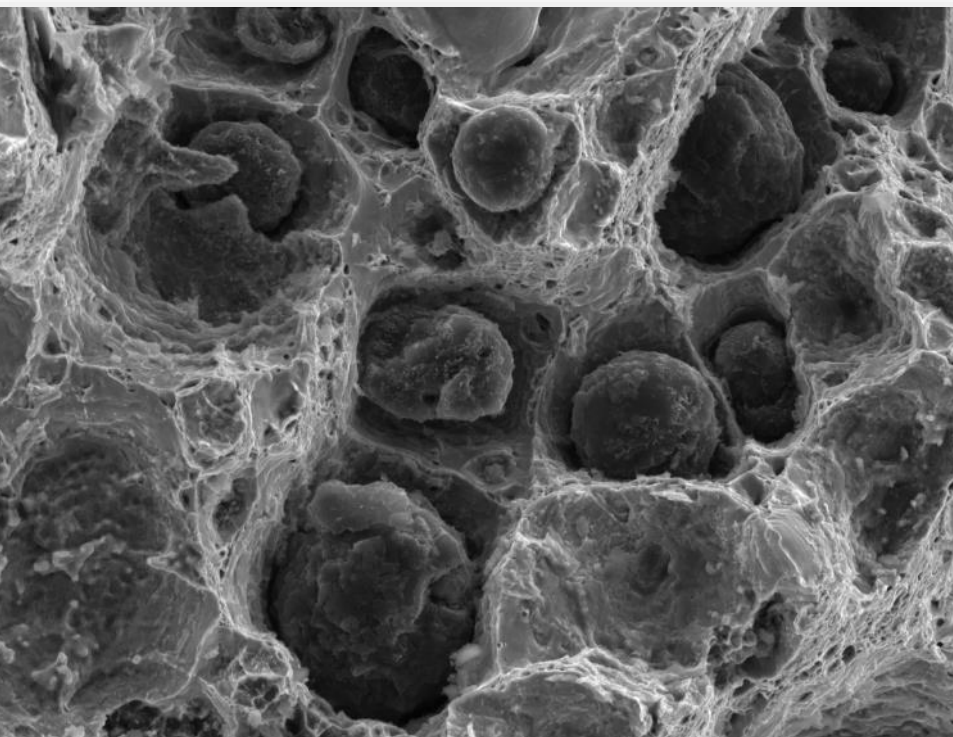
➤ ZOBRAZOVÁNÍ – HODNOCENÍ KONSTRUKČNÍCH MATERIÁLŮ

ADI

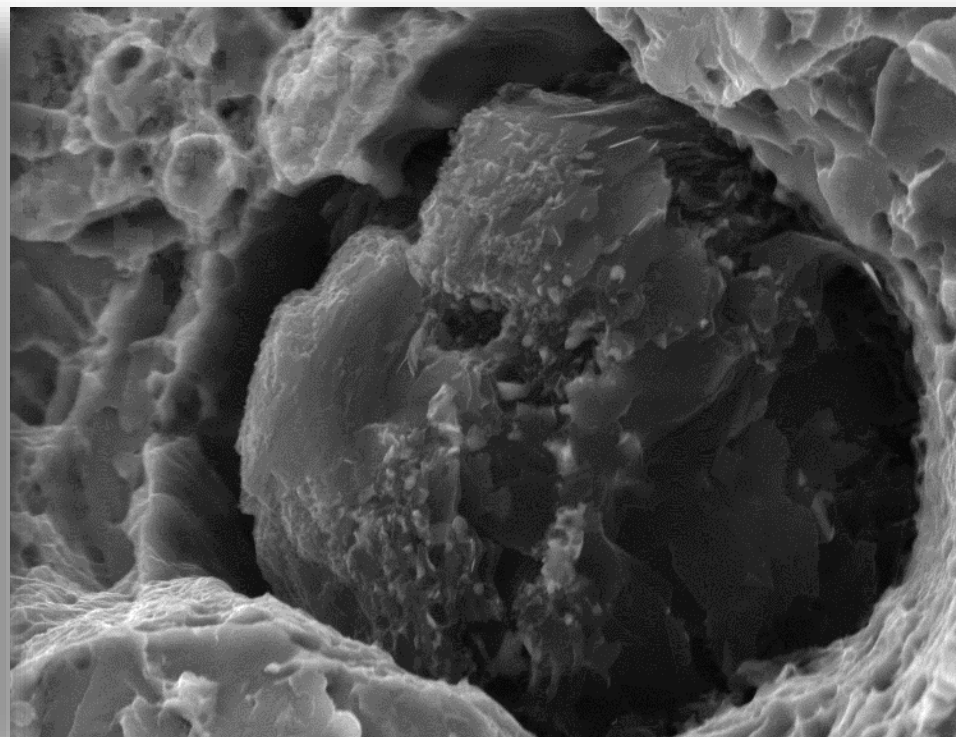


OBLAST VYUŽITÍ EM

➤ ZOBRAZOVÁNÍ – HODNOCENÍ KONSTRUKČNÍCH MATERIÁLŮ



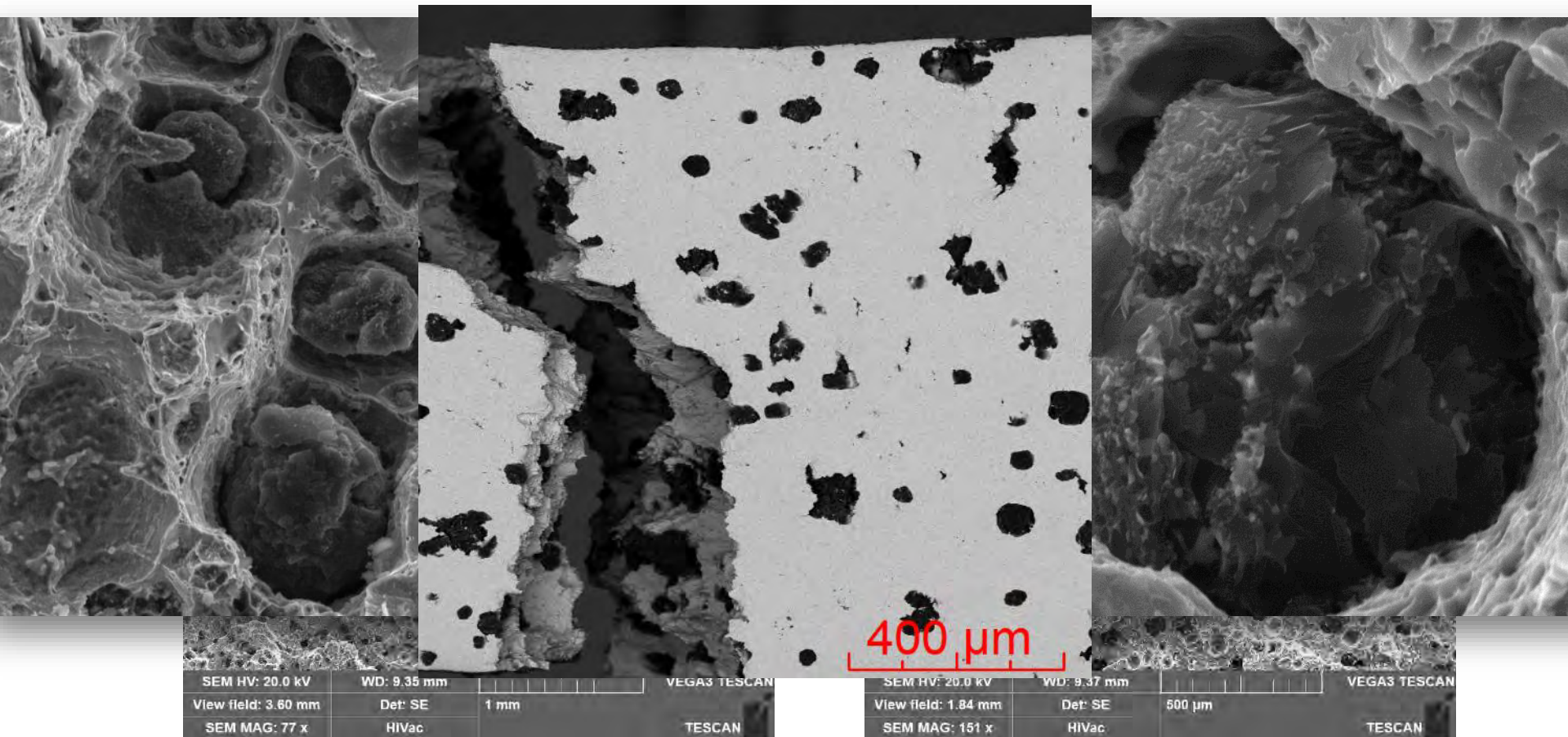
SEM HV: 20.0 kV	WD: 9.35 mm	VEGA3 TESCAN	
View field: 3.60 mm	Det: SE	1 mm	TESCAN
SEM MAG: 77 x	HIVac		



SEM HV: 20.0 kV	WD: 9.37 mm	VEGA3 TESCAN	
View field: 1.84 mm	Det: SE	500 µm	TESCAN
SEM MAG: 151 x	HIVac		

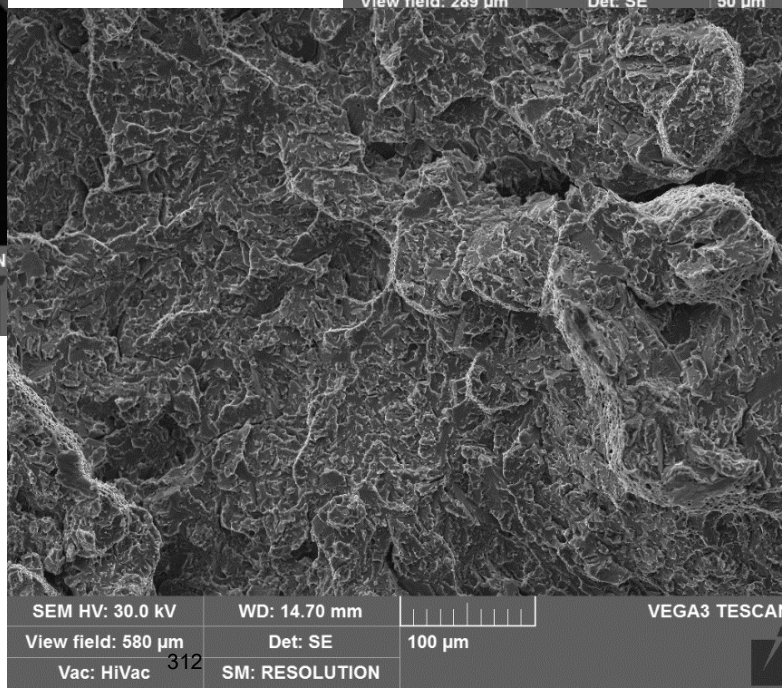
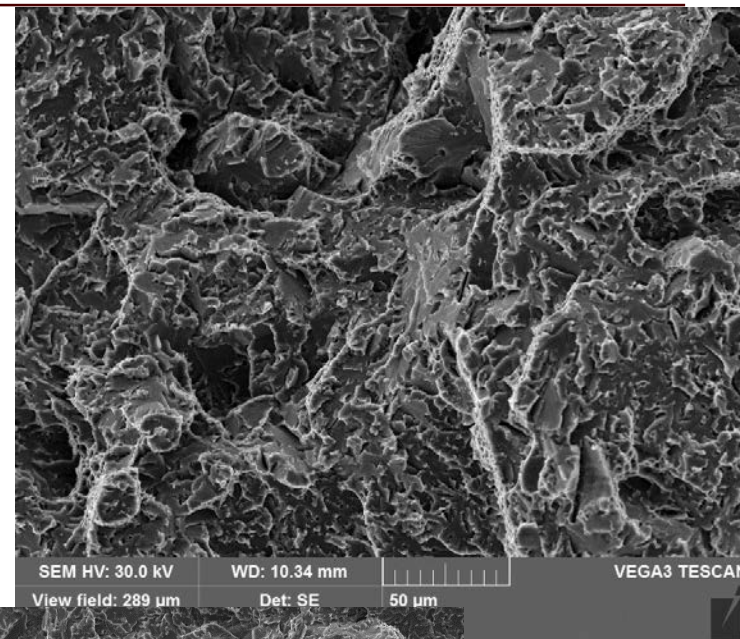
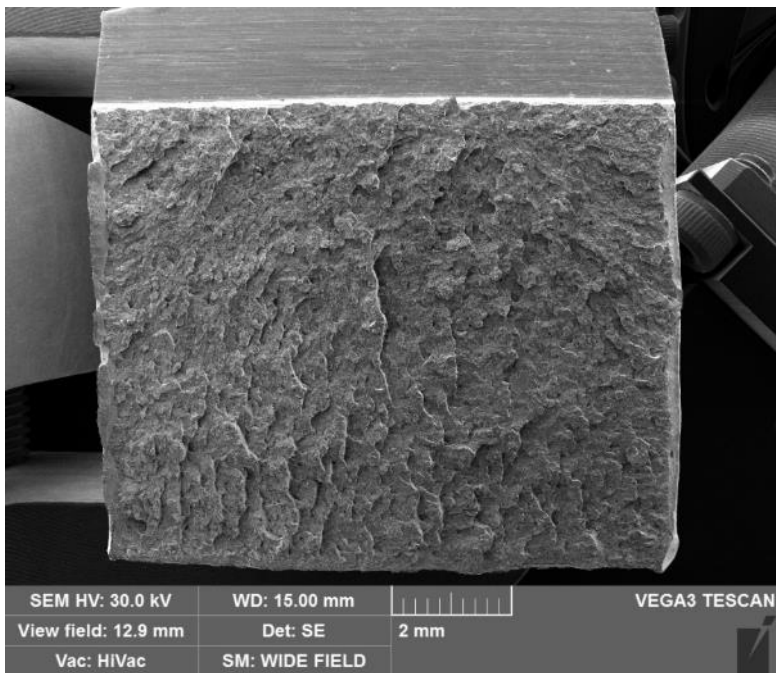
OBLAST VYUŽITÍ EM

➤ ZOBRAZOVÁNÍ – HODNOCENÍ KONSTRUKČNÍCH MATERIÁLŮ



OBLAST VYUŽITÍ EM

➤ ZOBRAZOVÁNÍ – IDENTIFIKACE LOMŮ



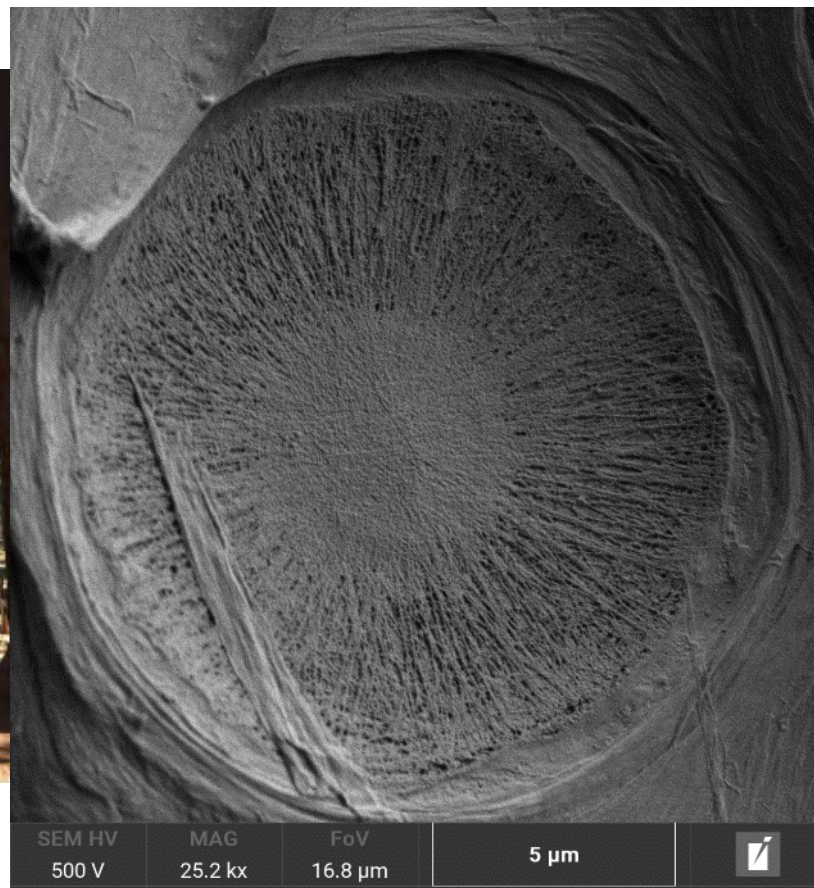
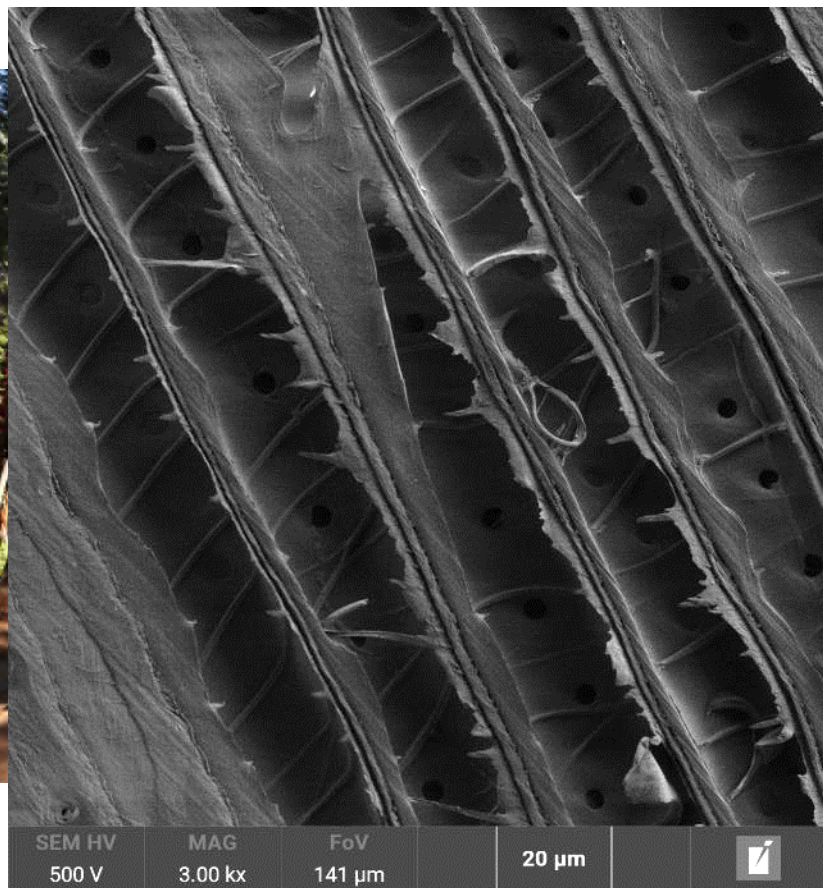
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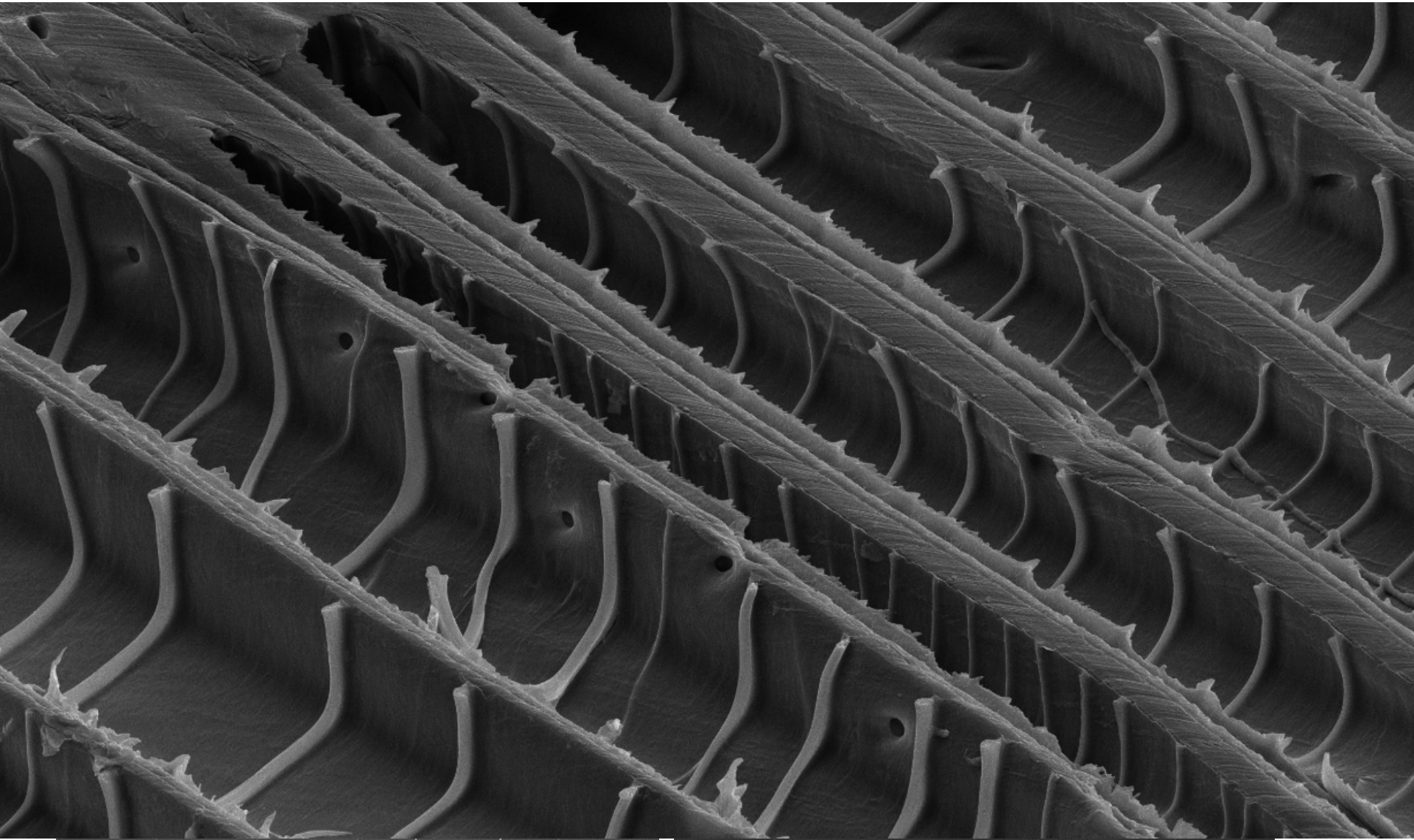
➤ ZOBRAZOVÁNÍ – BIO INSPIROVANÉ INŽENÝRSTVÍ



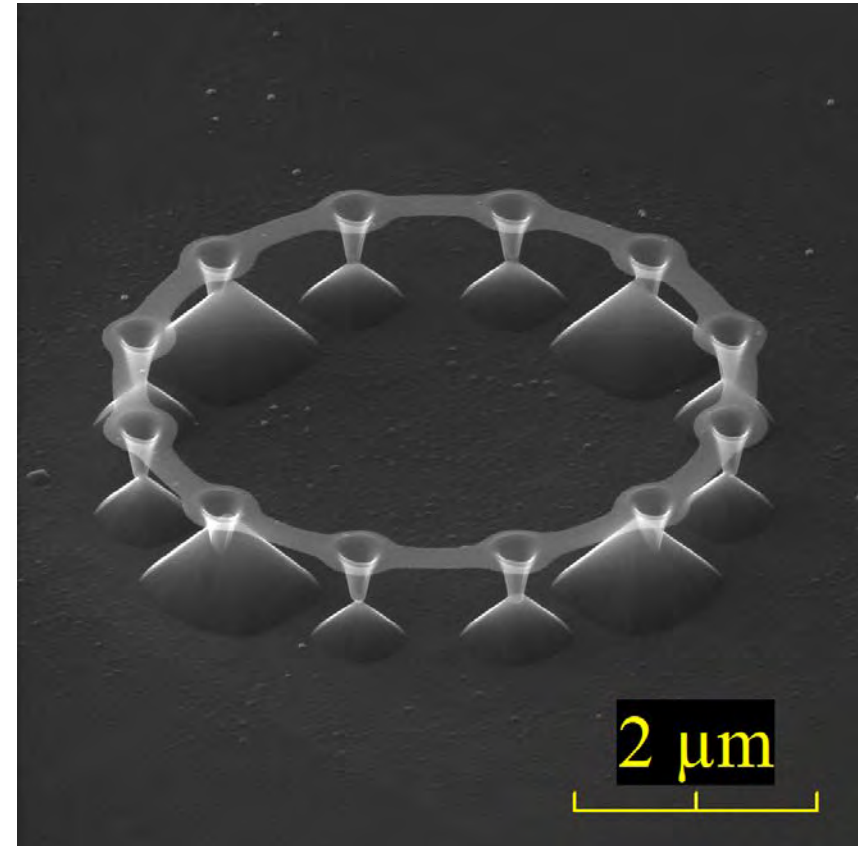
OBLAST VYUŽITÍ EM

➤ ZOBRAZOVÁNÍ – BIO INSPIROVANÉ INŽENÝRSTVÍ





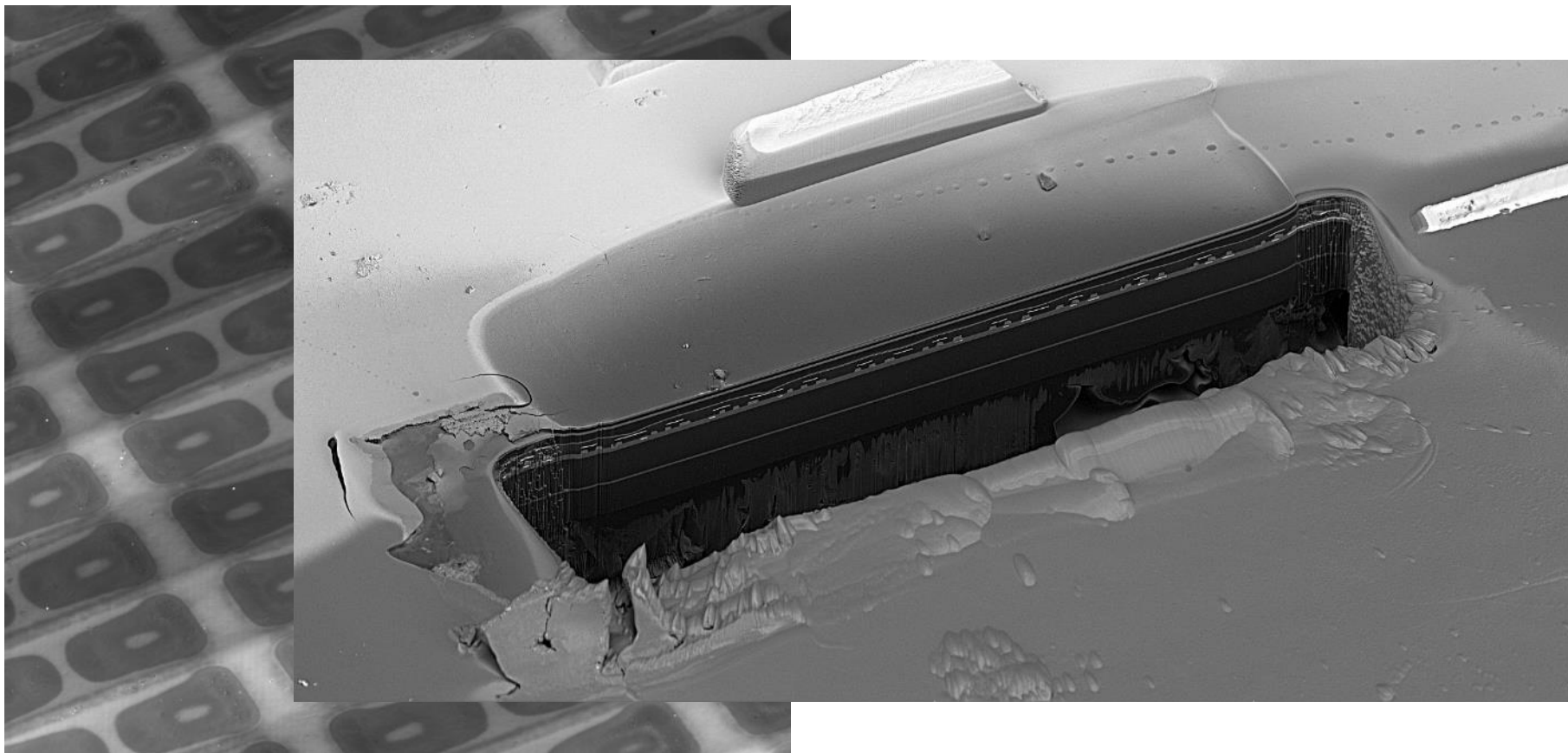
- TESCOAN
- CO JE TO MIKROSKOPIE?
- HISTORIE ELEKTRONOVÉ MIKROSKOPIE
- SROVNÁNÍ OPTICKÉ A ELEKTRONOVÉ MIKROSKOPIE
- PRINCIPY ELEKTRONOVÉ MIKROSKOPIE
- OBLASTI VYUŽITÍ
- **NENÍ MIKROSKOP JAKO MIKROSKOP**





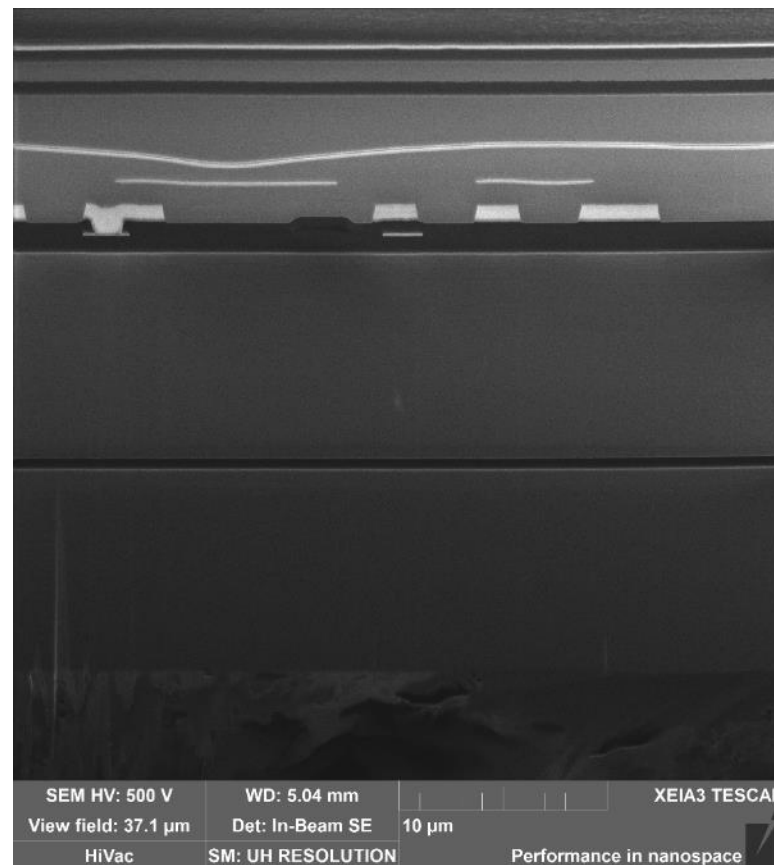
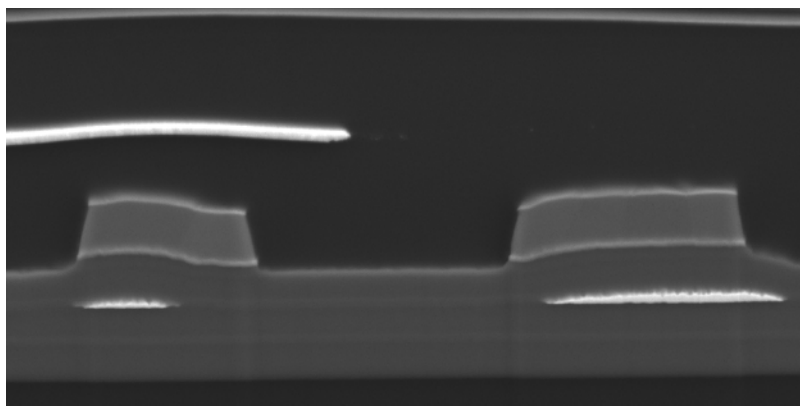
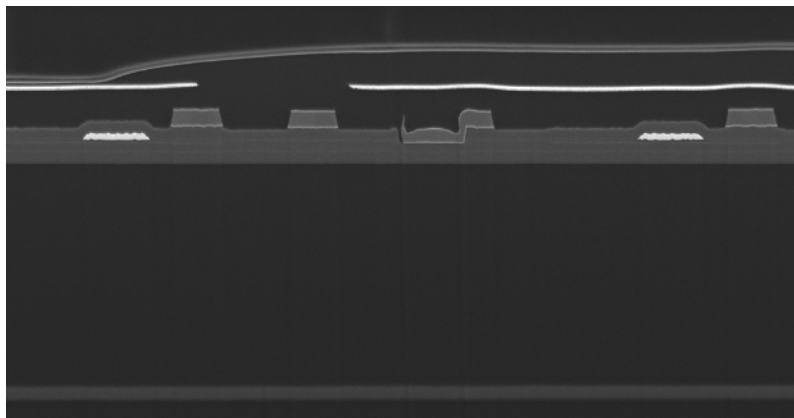
NENÍ MIKROSKOP JAKO MIKROSKOP

➤ ŘEŠENÍ PROBLÉMU V NANOSVĚTĚ



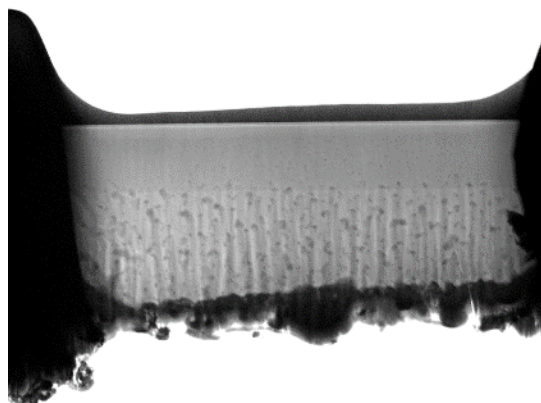
NENÍ MIKROSKOP JAKO MIKROSKOP

➤ ŘEŠENÍ PROBLÉMU V NANOSVĚTĚ

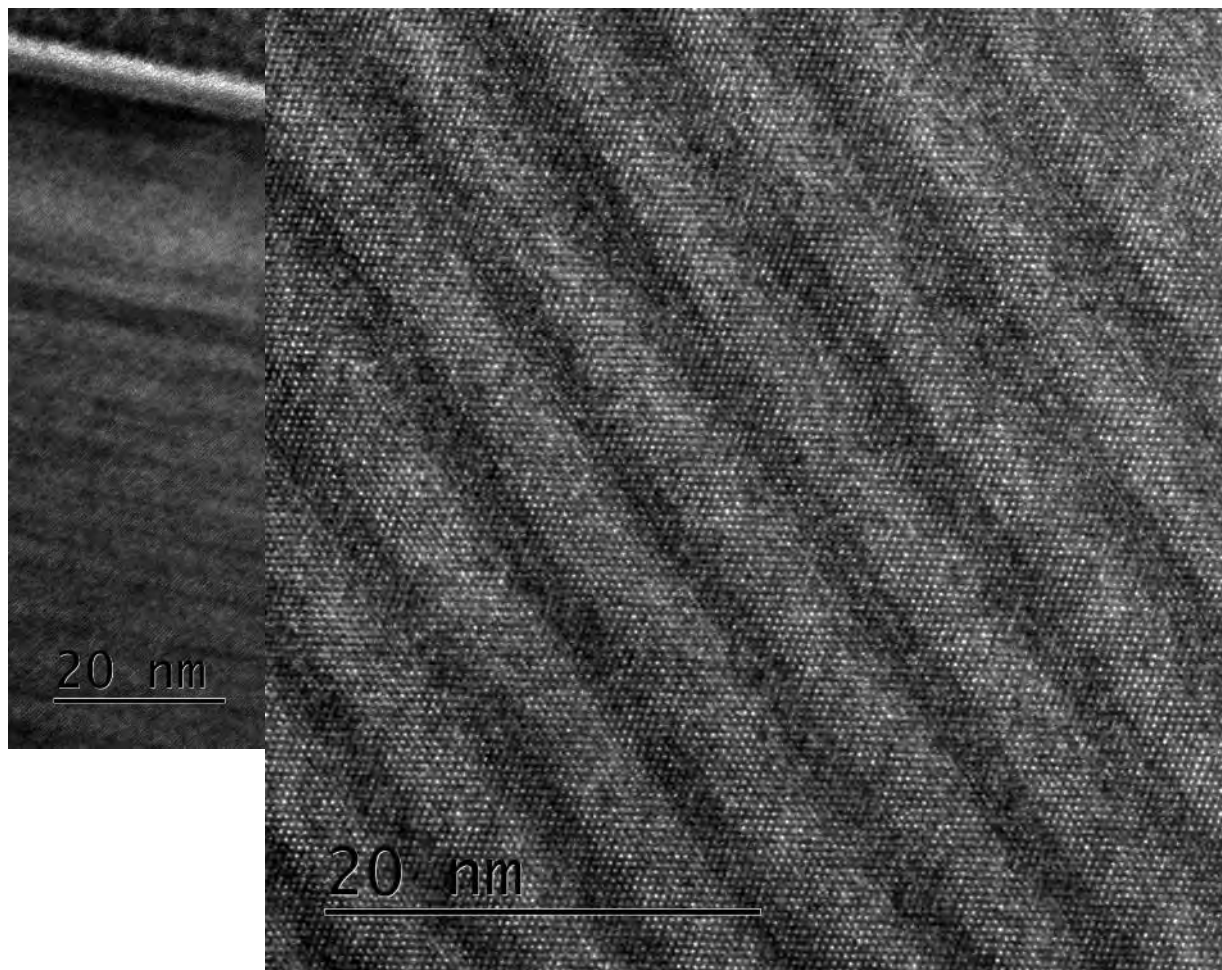


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➤ ŘEŠENÍ PROBLÉMU V NANOSVĚTĚ

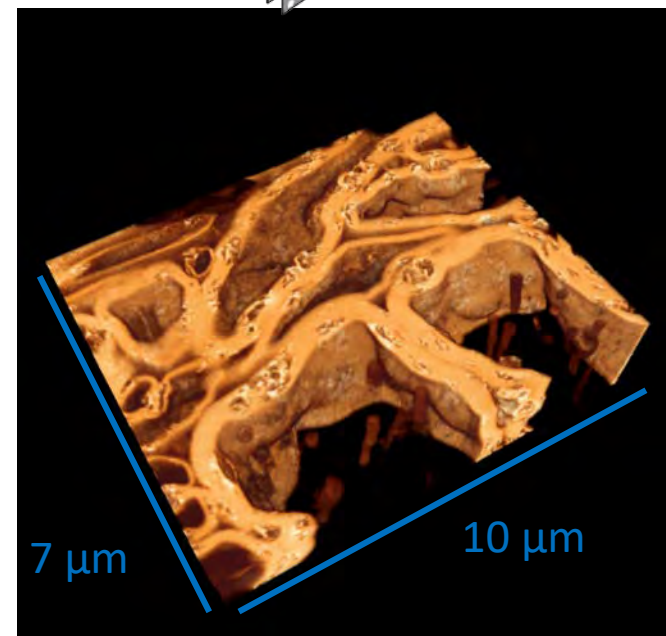
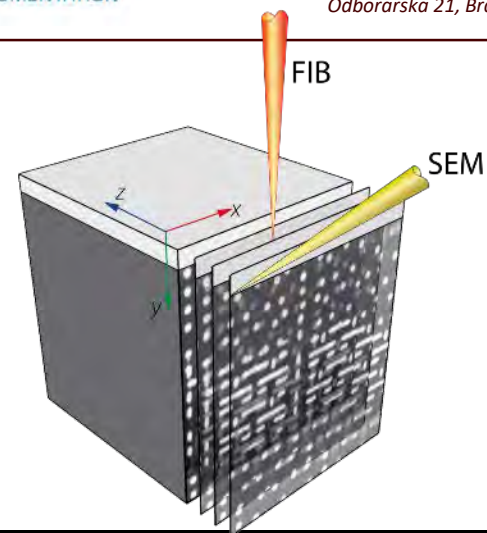


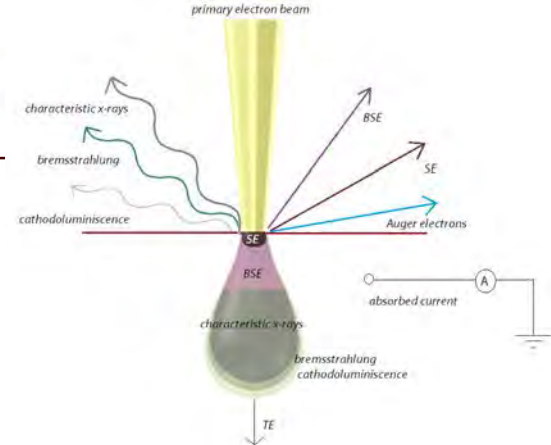
SEM HV: 30.0 kV	WD: 4.98 mm	XEIA3 TESCAN
View field: 6.96 μ m	Det: STEM Bright	2 μ m
HiVac	SM: DEPTH	Performance in nanospace



NENÍ MIKROSKOP JAKO MIKROSKOP

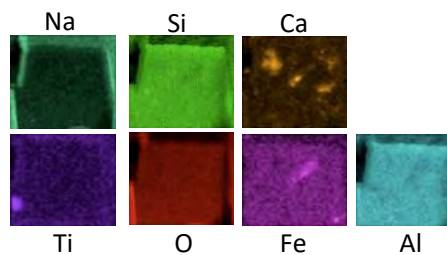
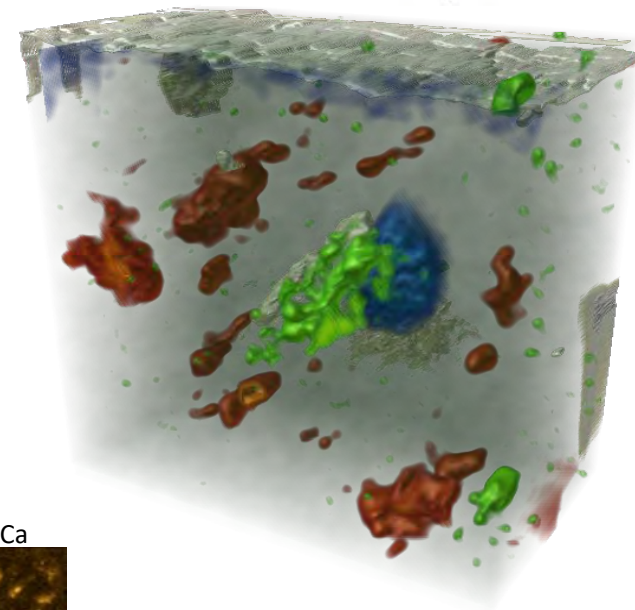
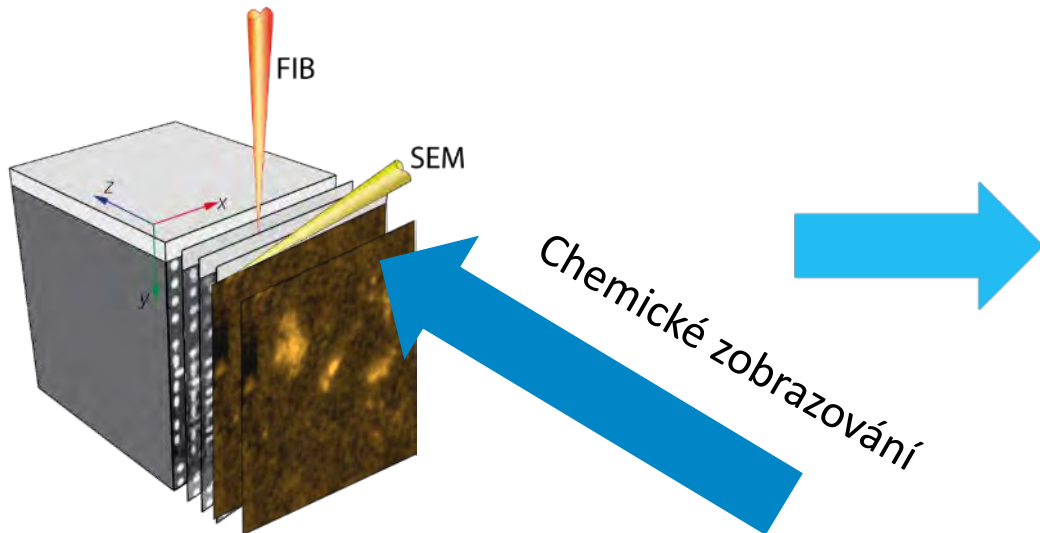
➤ 3D REKONSTRUKCE TKÁNĚ





NENÍ MIKROSKOP JAKO MIKROSKOP

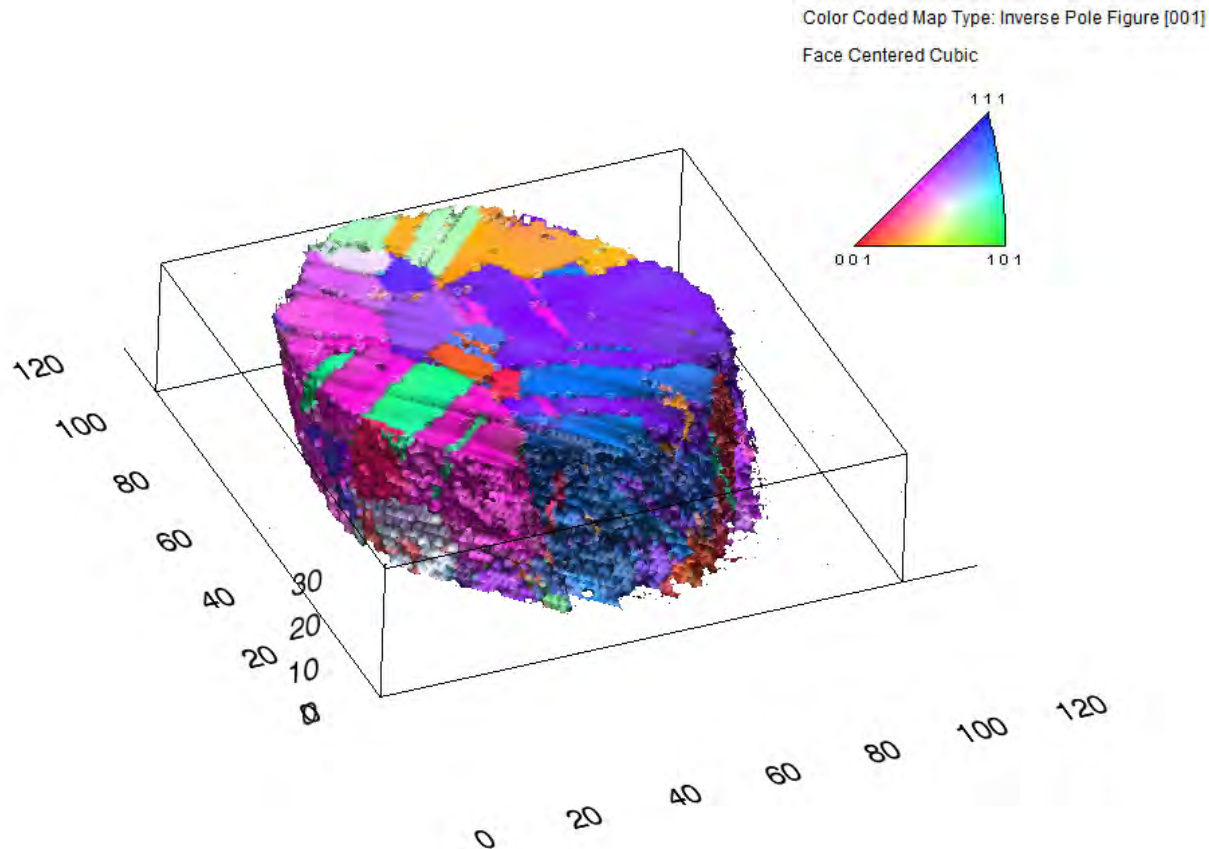
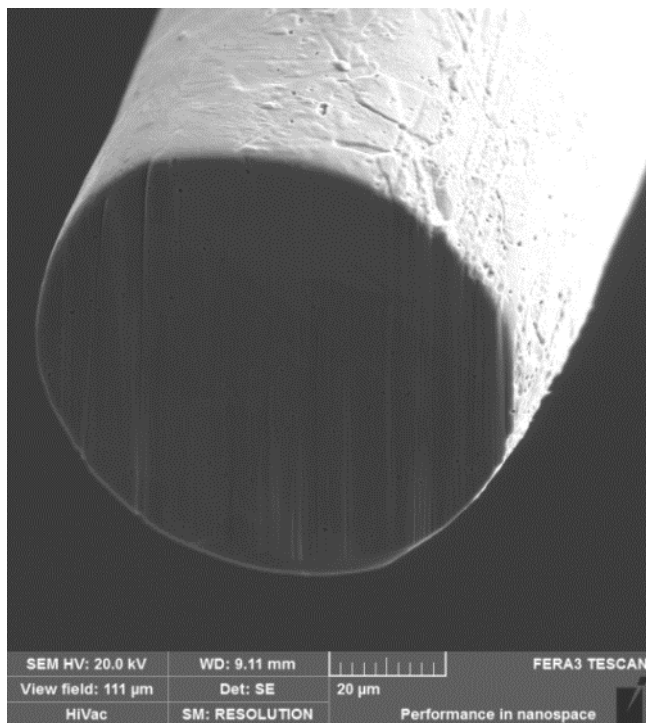
➤ CHEMICKÁ ANALÝZA - EDX



3D EDX analýza

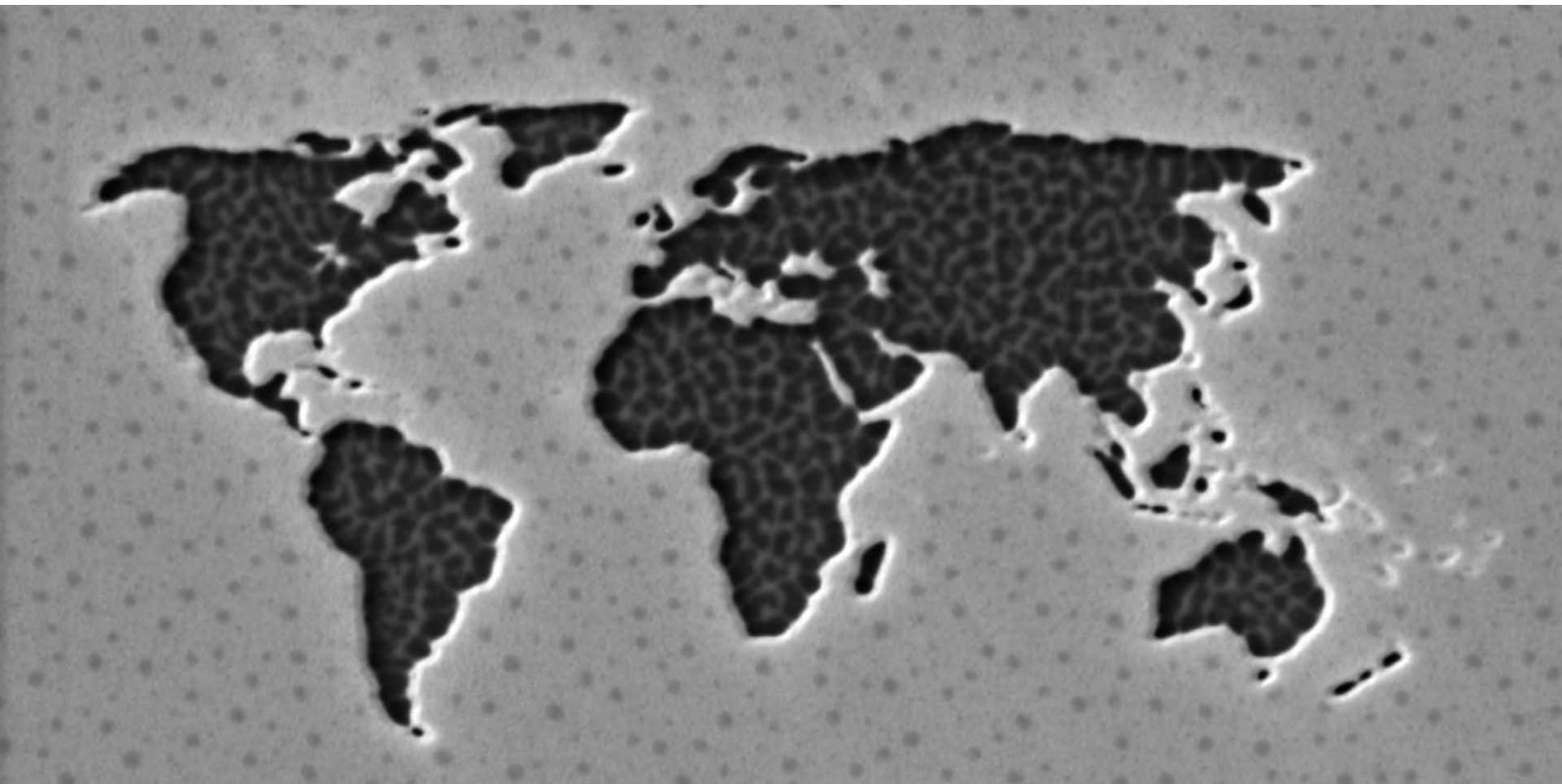
NENÍ MIKROSKOP JAKO MIKROSKOP

➤ EBSD



3D EBSD analýza

DĚKUJI ZA POZORNOST



CONTACTLESS MULTIDIMENSIONAL RIVER BED MEASUREMENT

Ing. Martin Kalafut, PhD. ¹

¹ AGIS Slovakia, spol. s r.o.

Abstract

The main goal of the presentation was to provide a basic information about contactless mapping system designed for mapping and inspection of river's bed. Such complex measuring system consists of the two integrated multibeam sonar heads transmitting sound signals in the interval of 200-400 kHz adjustable by the user with 10 kHz step. The signals – after their echo reception – are processed in real time by an appropriate managing software. Additional important parts of the whole mapping system are gyrocompass, velocity sensor and a GNSS receiver for positioning. All devices are mounted on a measuring vessel. After a mapping mission of an area of interest, all recorded data is processed in a suitable postprocessing software package, where everything is analysed, graphically presented and exported into a corporate GIS (Geographical Information System) for their integration and further analysis.

Key words: multibeam echosounder, gyrocompass, GNSS, real-time and postprocessing software, GIS

3rd INTERNATIONAL CONFERENCE

3D MEASUREMENT AND IMAGING

*MODERN CONTACTLESS MEASUREMENTS
IN INDUSTRIAL PRACTICE*

**CONTACTLESS MULTIDIMENSIONAL
MEASUREMENT OF RIVER'S BED**

Ing. Martin Kalafut, Ph.D.

BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

- Projekt:

FAIRway Danube
INEA/CEF/TRAN/M2014/1043119

Waterborne Transport Development Agency
Agentúra rozvoja vodnej dopravy

ARVD

FAIRway
Danube



Co-financed by the Connecting Europe
Facility of the European Union

BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

- Meracie plavidlo



BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

► Merací systém



BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

► Merací systém Kongsberg

- MBES EM2040C Dual Head

The EM 2040C (C for Compact) is a shallow water multibeam echo sounder based on the EM 2040 technology, an ideal tool for any high resolution mapping and inspection application. The receiver and transmitter are integrated in a common sonar head, with the same dimensions as its predecessor EM 3002. The system fulfils and even surpasses the IHO-S44 special order and the more stringent LINZ specification.

EM 2040C multibeam system features

- High resolution
- Wide frequency range
- Short pulse lengths and large bandwidth
- Extended range due to Frequency Modulated (FM) chirp
- Complete roll and pitch stabilization
- Nearfield focusing both on transmit and receive
- Water column data (standard)
- Seabed image (standard)
- Sonar head is depth rated to 50 m
- Easy to install, convenient for small boats
- Single and Dual Head models
- Dual swath (multiple pings)



Dual head configuration



BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

Frequency range: 200 to 400 kHz in steps of 10 kHz
 Beam width: 1 * 1 degree at 400 kHz
 Max ping rate: 50 Hz
 Swath coverage sector: Up to 130 degrees (single head) / 200 degrees (dual head)
 Sounding patterns: Equiangular, equidistant and high density
 No. of soundings per ping: 400 (single head, single swath)
 800 (single head, dual swath)
 1600 (dual head, dual swath)
 Roll stabilised beams: +/-15 degrees
 Pitch stabilised beams: +/-10 degrees
 Yaw stabilised beams: +/-10 degrees (Dual head)

Coverage example for EM 2040C in cold ocean water with bottom type rock (BS = - 10 dB), NL = 45 dB, FM mode			
Operating frequency	Max depth	Max coverage across	
		Single head	Dual head
200 kHz	520 m	580 m	700 m
300 kHz	450 m	580 m	670 m
350 kHz	400 m	510 m	600 m
400 kHz	350 m	375 m	530 m

	200 - 400 kHz in 10 kHz step	200 - 400 kHz in 10 kHz step
	CW	FM
Pulse lengths	14, 27, 54, 135, 324 and 918 µs	3 and 12 ms

BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

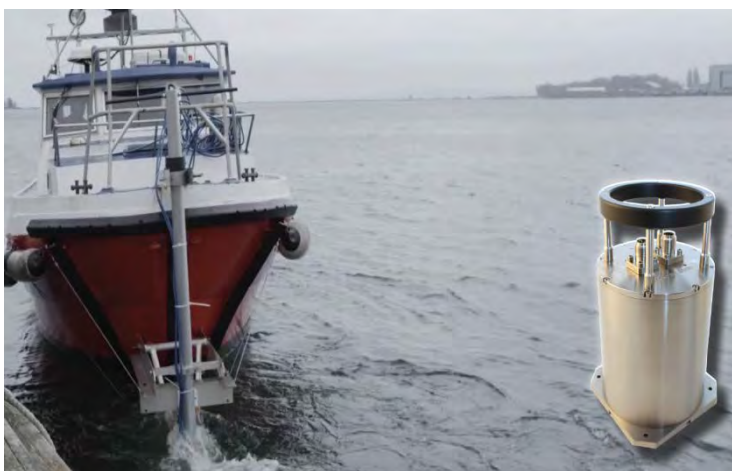
Physical dimensions (excluding connectors and mounting arrangements)			
Sonar head EM 2040C	332 x 119 (diameter x height)	18.8 kg (8.4 kg in water)	Depth rating 50 m
Sonar head EM 2040CX	332 x 122 (diameter x height)	26.1 kg (17 kg in water)	Depth rating 1500 m
Processing Unit (2U 19" rack)	482.5 x 424 x 88.6 mm (WxDxH)	10.5 kg	NA

BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

► MGC R3 SB50

Typical applications

The MGC R3 SB50 is designed for portable seabed mapping systems where the MGC is to be mounted on the multibeam transducer head. With input of data from a GNSS system, the MGC R3 SB50 is a fully inertial navigation system (INS). It can output heading, roll, pitch, heave and position. Acceleration and velocity of linear motions, as well as angular rates, are output from the unit. The MGC product outputs both processed and raw (gyro and accelerometer) sensor data.



FEATURES MGC R3 SB50

- 0.01° roll and pitch accuracy
- 0.08° secant latitude heading accuracy with GNSS aiding
- Includes INS capability
- Delivered in titanium housing, depth rated to 50 metres
- Outputs on RS-422 and Ethernet
- High output data rate (200 Hz)
- Precise heave at long wave periods by use of PFreeHeave® algorithms
- Lever arm compensation to two individually configurable monitoring points
- Small size and low power consumption
- Each MGC delivered with a Calibration Certificate
- Selectable communication protocols in the Windows based configuration software



BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

ORIENTATION OUTPUT

Angular orientation range	±180°
Resolution in all axes	0.001°
Accuracy roll, pitch	0.01° RMS
Accuracy heading (GNSS aided)	0.08° RMS sec.lat
Heading settling time (typical)	17 min from start-up

GYRO OUTPUT

Angular rate range	±149°/s
Angular rate noise	0.010°/s RMS
Bias stability (absolute bias)	0.008°/h RMS
Angle Random Walk	0.008°/√h
Scale factor error	0.001 % RMS

ACCELERATION OUTPUT

Acceleration range (all axes)	±45 m/s ²
Bias stability (absolute bias)	80 µg RMS
Acceleration noise	0.0002 m/s ² RMS
Velocity Random Walk	3.3 µg/√h
Scale factor error	0.008% RMS

HEAVE OUTPUT

Output range	±50 m, adjustable
Periods (real-time)	0 to 25 s
Periods (delayed)	0 to 50 s
Heave accuracy (real-time)	5 cm or 5% whichever is highest
Heave accuracy (delayed)	2 cm or 2% whichever is highest

POSITION OUTPUT

Free inertial	5 nm/h
---------------	--------

ELECTRICAL

Power requirements

Serial ports:

Com1

Com2

Com3 & Com4

Analog channels (junction box)

Ethernet output ports

Ethernet UPD/IP

Digital output variables

Data output rate (max)

Timing

4, ±10 V, 14 bit resolution

5

10/100 Mbps

24 (max), Serial or Ethernet

200 Hz

< 1 ms

ENVIRONMENTAL SPECIFICATIONS

Temperature range

Humidity range, electronics

Vibration

-5 °C to +55 °C

Sealed, no limit

IEC 60945/EN 60945

ELECTROMAGNETIC COMPATIBILITY

Compliance to EMCD,
immunity/emission

IEC 60945/EN 60945

OTHER DATA

MTBF (computed)

Dimensions (HxLxW)

Material

Dry weight

Submerged weight

Connector

50000 h

275 x 184 x 184 mm

Anodised aluminium

10.5 kg

5.5 kg

2 8-pin Seacon 5506-1508
(male)

INPUT FORMATS

NMEA 0183, incl. GGA, VBW, VTG, ZDA or MRU Normal format

OUTPUT FORMATS

- MRU normal

- NMEA 0183 proprietary

- Atlas Fansweep

- Seapath binary 23, 25, 26

- Sounder

- EM3000

- TSS1

- PFreeHeave®

12 to 28 V DC, max 12 W

Bidirectional RS-422

Output only, RS-422

Input only, user
configurable RS-232,
RS-422

BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

- MiniSVS (Sound Velocity Sensor)



Sound Velocity Measurement

Each sound velocity measurement is made using a single pulse of sound travelling over a known distance, so is independent of the inherent calculation errors present in all CTDs. Our unique digital signal processing technique virtually eliminates signal noise, and gives almost instantaneous response; the digital measurement is also entirely linear, giving predictable performance under all conditions.

Range:	1375 - 1900m/s	
Resolution:	0.001m/s	
Accuracy:	Dependent on sensor size	
100mm	Random noise (point to point)	±0.002m/s
	Max systematic calibration error	±0.013m/s
	Max systematic clock error	±0.002m/s
	Total max theoretical error	±0.017m/s
50mm	Total max theoretical error	±0.019m/s
25mm	Total max theoretical error	±0.020m/s

Acoustic Frequency: 2.5MHz

BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

- miniSVP (Sound Velocity Profiler)



The miniSVP has been developed to provide a cost effective tool for the collection of Sound Velocity Profiles without compromising the quality of the data. Ideally suited to ROV, coastal, or small boat applications, the miniSVP will appeal to survey companies, military and academia alike, being simple to use and easy to handle.

Sensors

The miniSVP is fitted with Valeport's digital time of flight sound velocity sensor, a PRT temperature sensor, and strain gauge pressure transducer.

Sound Velocity

Range:	1375 - 1900m/s
Resolution:	0.001m/s
Accuracy:	±0.02m/s

Temperature

Range:	-5°C to +35°C
Resolution:	0.001°C
Accuracy:	±0.01°C

Pressure

Range:	5, 10, 30, 50, 100, 300 or 600 Bar
Resolution:	0.001% range
Accuracy:	±0.05% range

BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

- GNSS prijímač Trimble R10-2 (NMEA: GGA, GST, ZDA, VTG, IPPS, SKPOS)



A new level of productivity

8 mm H / 15 mm V

Max. Precision

672

Channels

Integrated

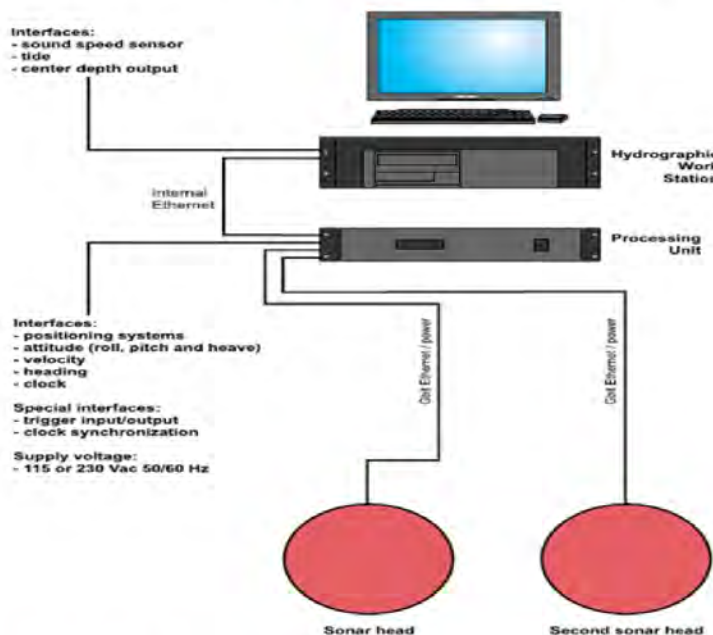
Antenna



BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

- Schéma zapojenia

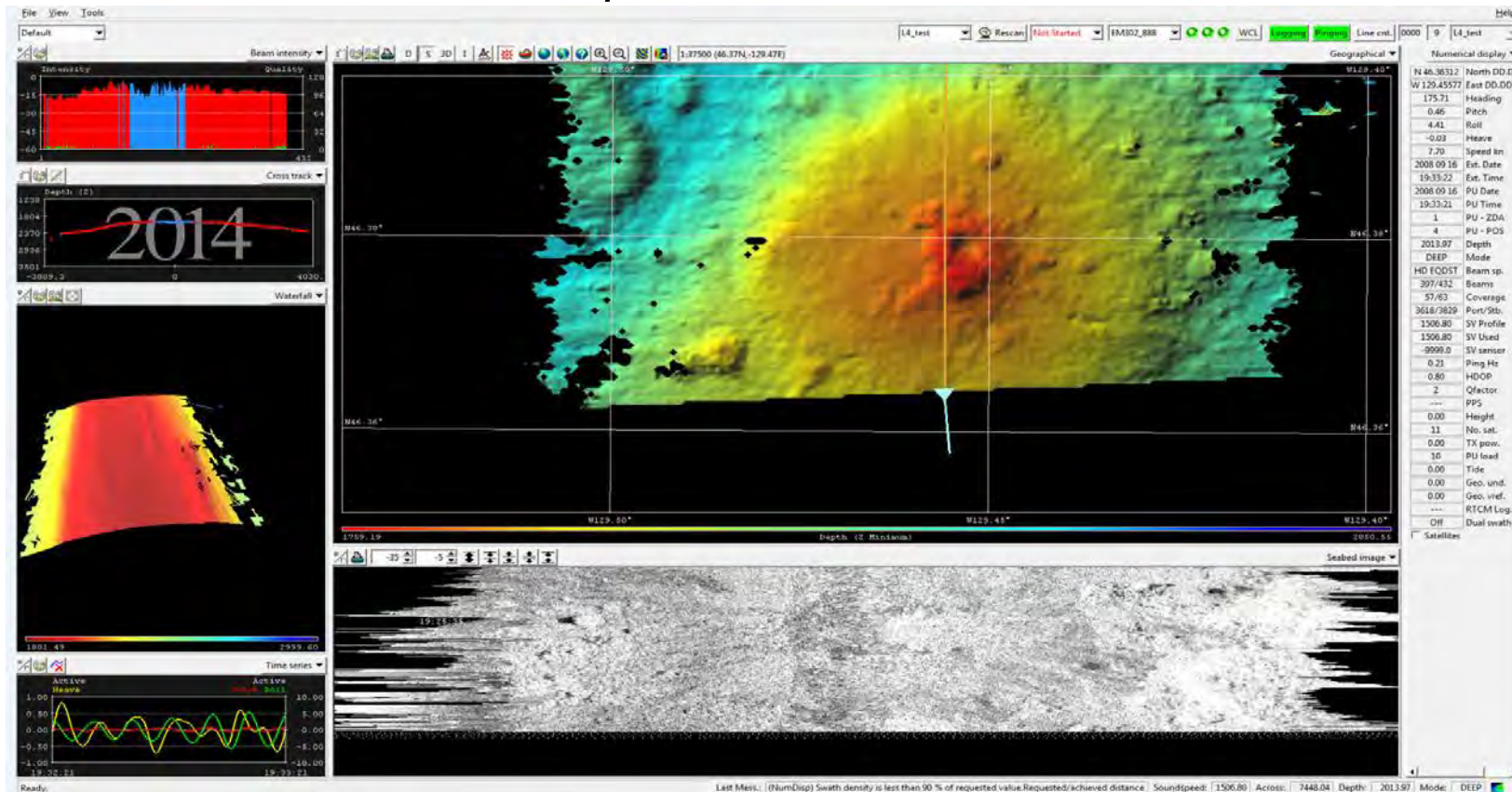
4.1.1 System Diagram EM[®] 2040C Dual Head, Single Swath



Note: Dual Swath (1600 soundings per ping) is archived for an EM 2040C Dual Head, Single Swath System by adding a second Processing Unit with 2 (two) CBMF (beamforming) cards installed.

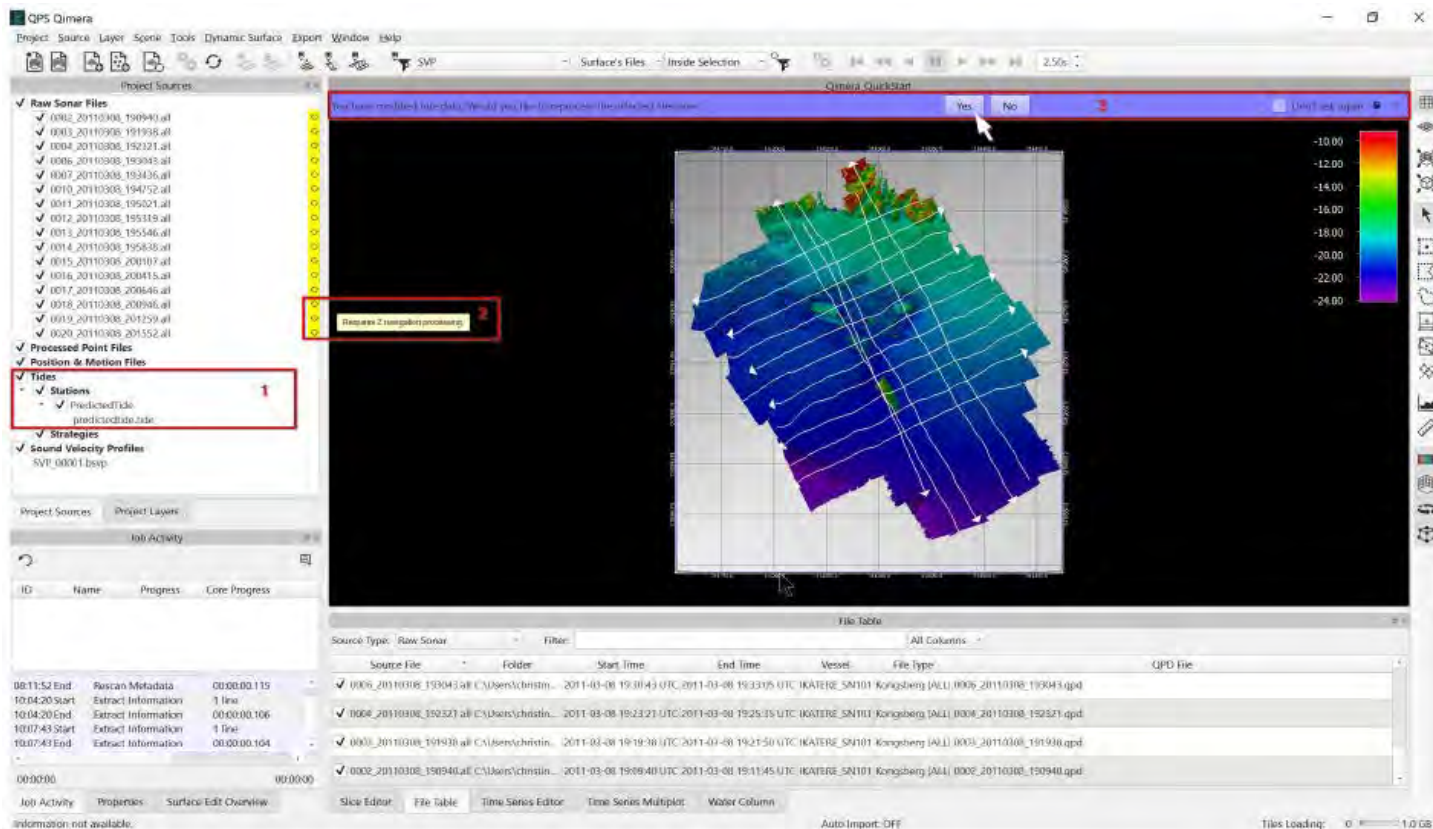
BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

- SIS (Seabed Information System) riadiaci softvér



BEZKONTAKTNÉ VIACDIMENZIONÁLNE MERANIE RIEČNEHO DNA

- QIMERA + FLEDERMAUS spracovateľský softvér



ĎAKUJEM ZA POZORNOSŤ



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Title: Abstrakty a prednášky z 3. ročníka konferencie 2018 (Abstracts and Presentations of the 3rd International Conference **3D MEASUREMENT AND IMAGING**, held in Bratislava, Odborárska 21, Slovakia), October 10-11, 2018.

Published by: SEA - Agentúra pre vzdelanie a vedu

Editors and designers: Mgr. Michaela Reichelová, Mgr. Melinda Hegyiová

Number of pages: 386

ISBN 978-80-972082-5-7 (e-document)

ISBN 978-80-972082-5-7

