CEITEC

Central European Institute of Technology

BRNO | CZECH REPUBLIC

MUNI

Jan Přibyl

CF NanoBio Head

Masaryk university, Brno, Czech Republic

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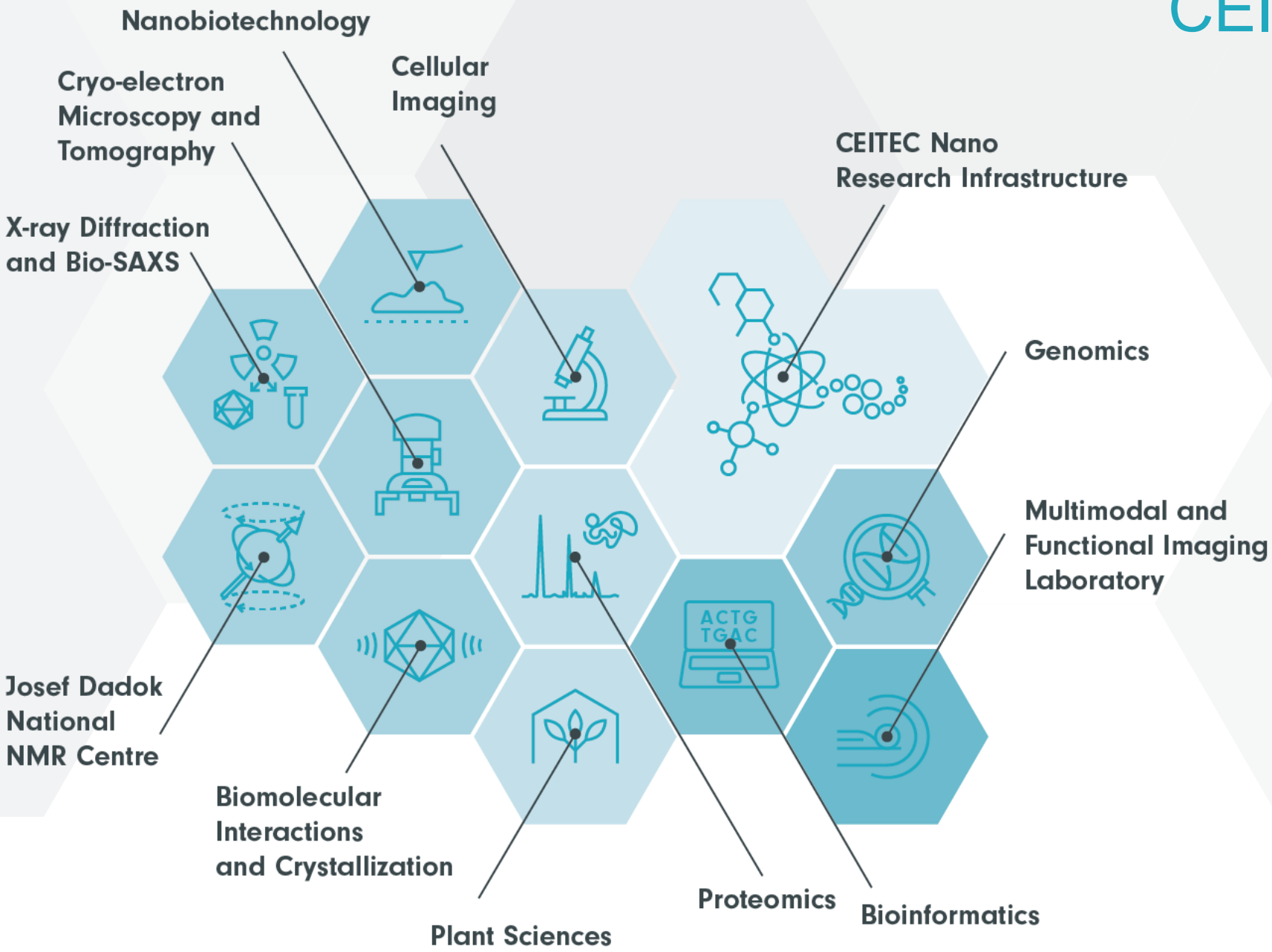
Nanobiotechnology Core Facility

Summer workshop on BioAFM microscopy 2023

CEITEC consortium

Core Facilities



Core Facility Nanobiotechnology

Imaging, mechanical mapping, Raman microscopy

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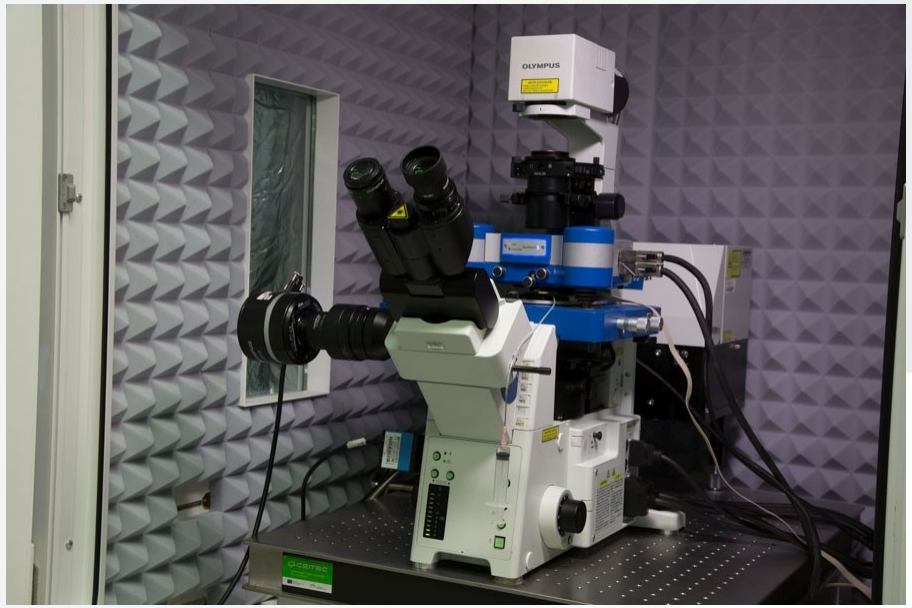
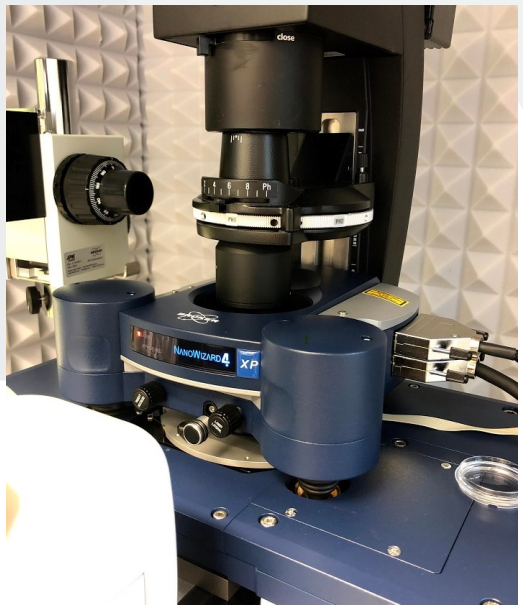
CF NanoBio Introduction

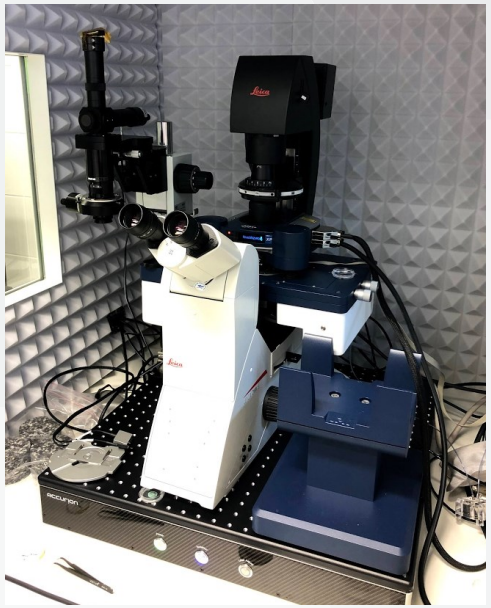
- Established 2013
- CF helps researchers (structural biologists, biochemists, and chemists) better understand the **complex cellular processes**
- **Nanometer-scale imaging** - single **biomolecules** and **nano-objects** and their complexes with biomolecules.
- Monitoring **biological samples** in their **native state** and their physiological environments
- Strong role of **biomechanics** and **chemical composition** of single biomolecules, nano-objects, living cells, and
- CF technology - **AFM** probe microscopy, **Optical microscopy**, **Raman** microscopy, **Multielectrode array, Biosensor platforms, Fluid AFM, NanoIndentors**
- **Strategy** - to conduct **cutting-edge research**, **competitiveness,** recruitment and retaining of strong internal and external users, and competitiveness for external research funding
- **Mission** - service and maintenance of exceptional and **expensive equipment** to offer a **cost-effective** and maximally productive environment
- **Vision - excellence** in everything we do, **communication** with users - consistent flow of information.

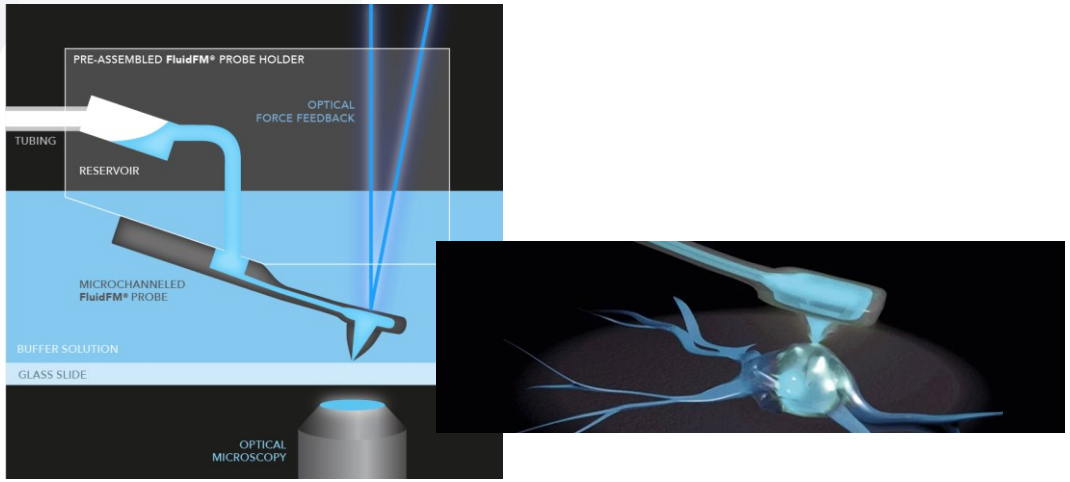
CF NanoBio - Equipment

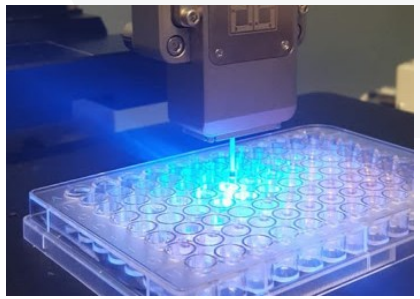
JPK NanoWizard 3 and 4 with extended scanning range











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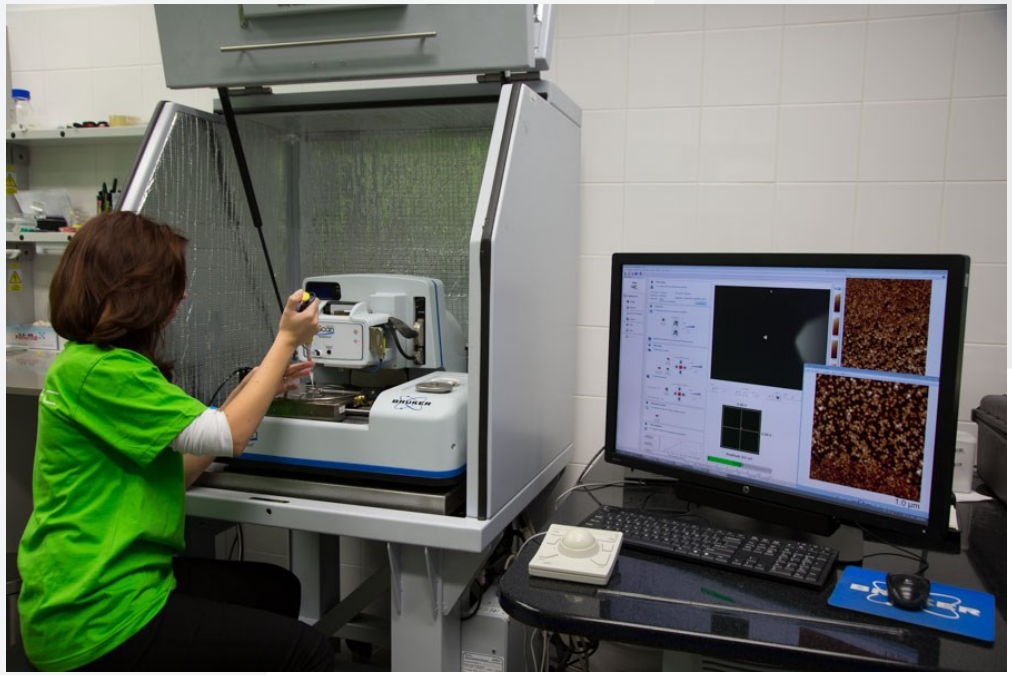
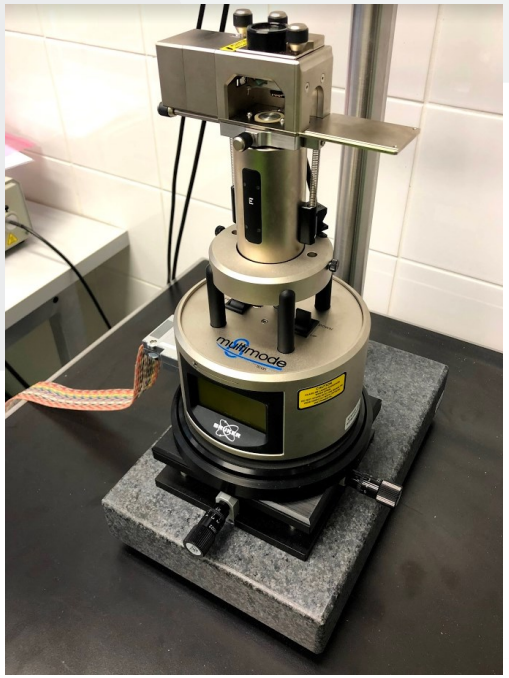
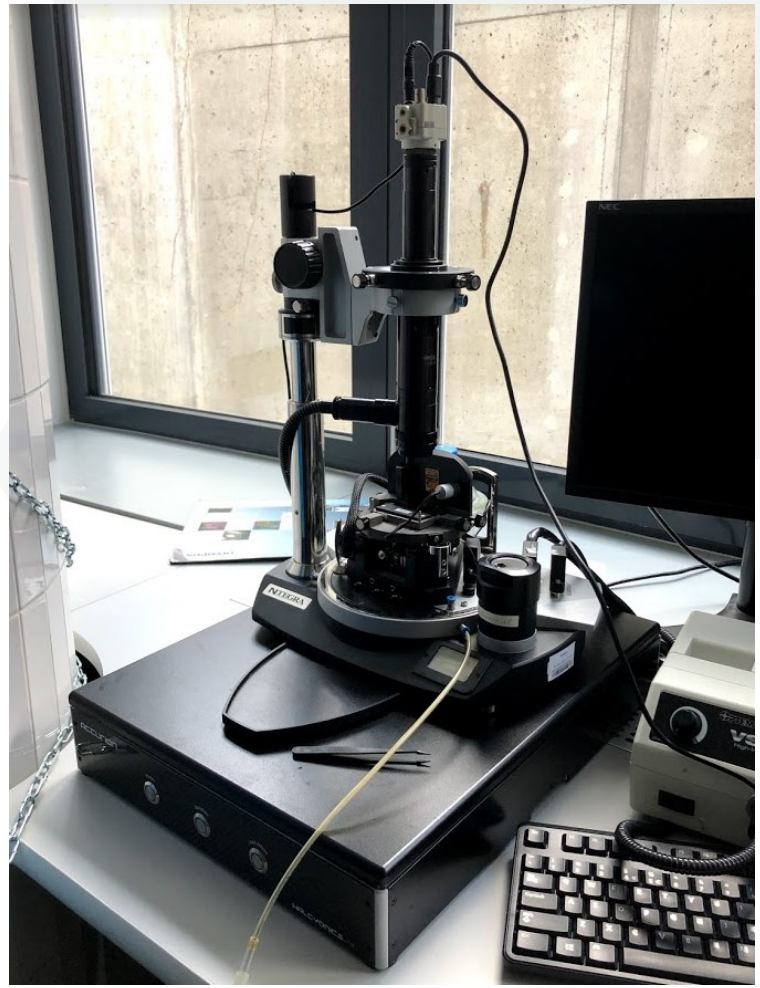
+ CytoSurge FluidFM module

+ Biosoft NanoIndenter







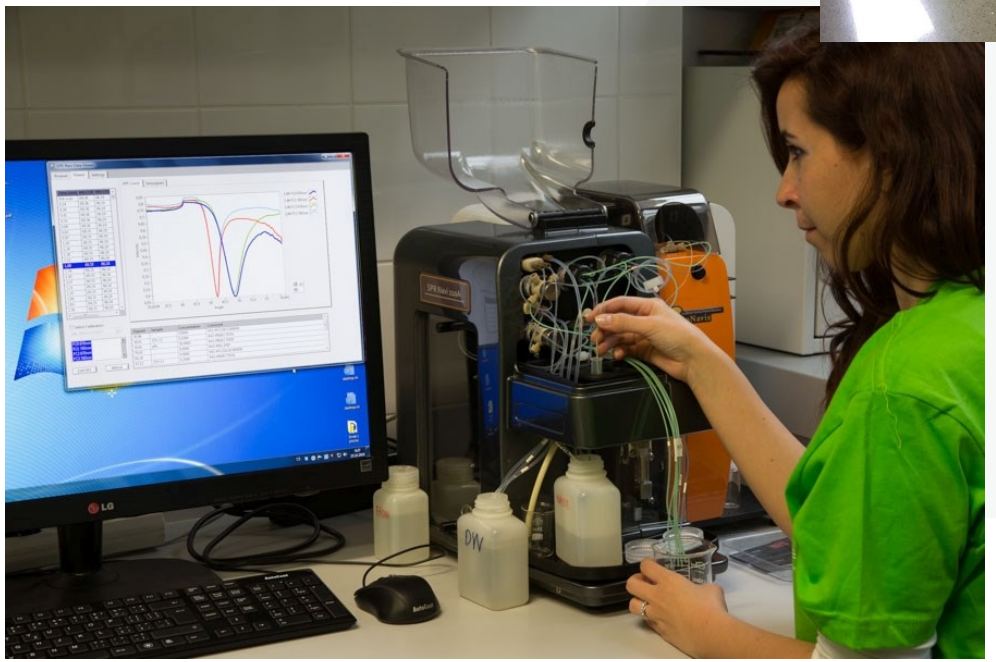
Bruker Dimension Icon FastScan and MultiMode 8HR
NTMDT Ntgra Vita

Raman microscopy, SPR affinity biosensor, Upconverting particles UCNP reader

Renishaw InVia Raman microscope

Bionavis SPR biosensor device

Labrox UPCON reader



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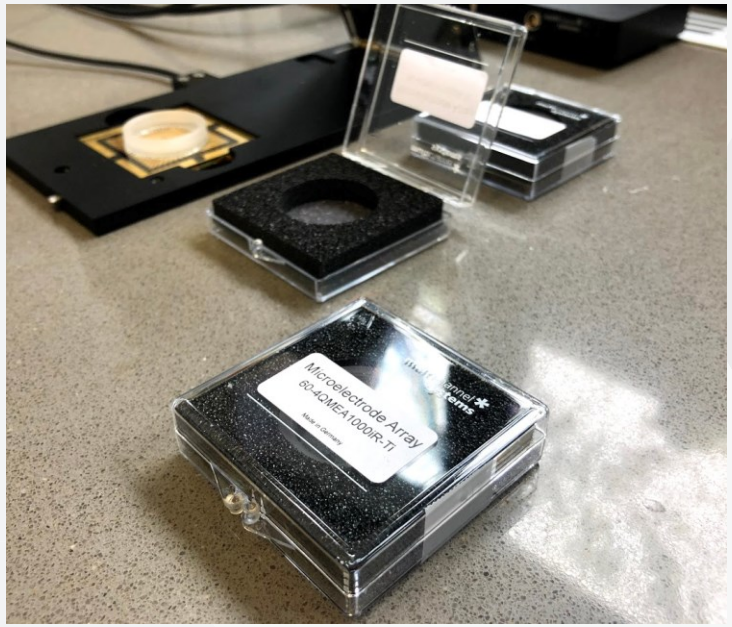
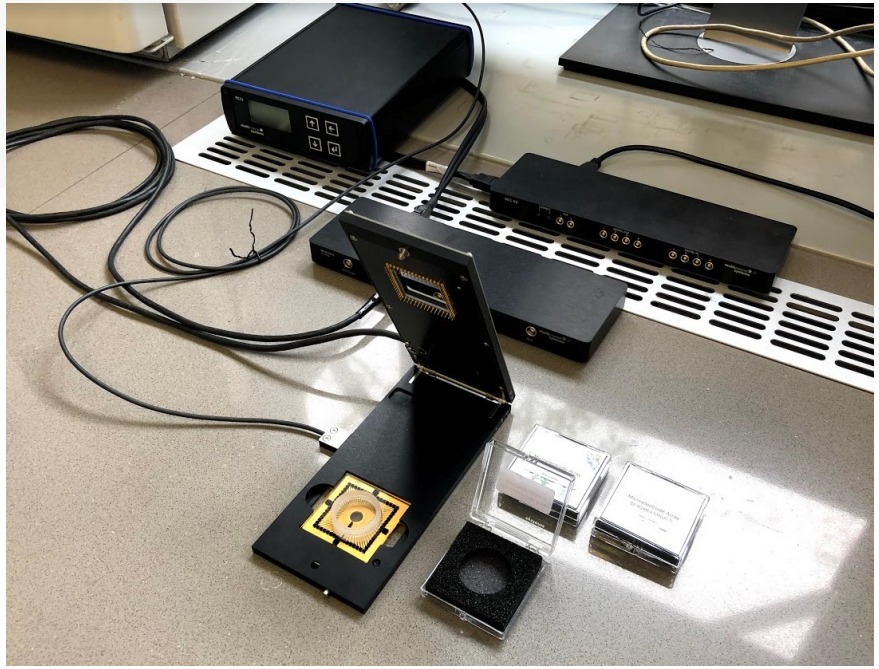
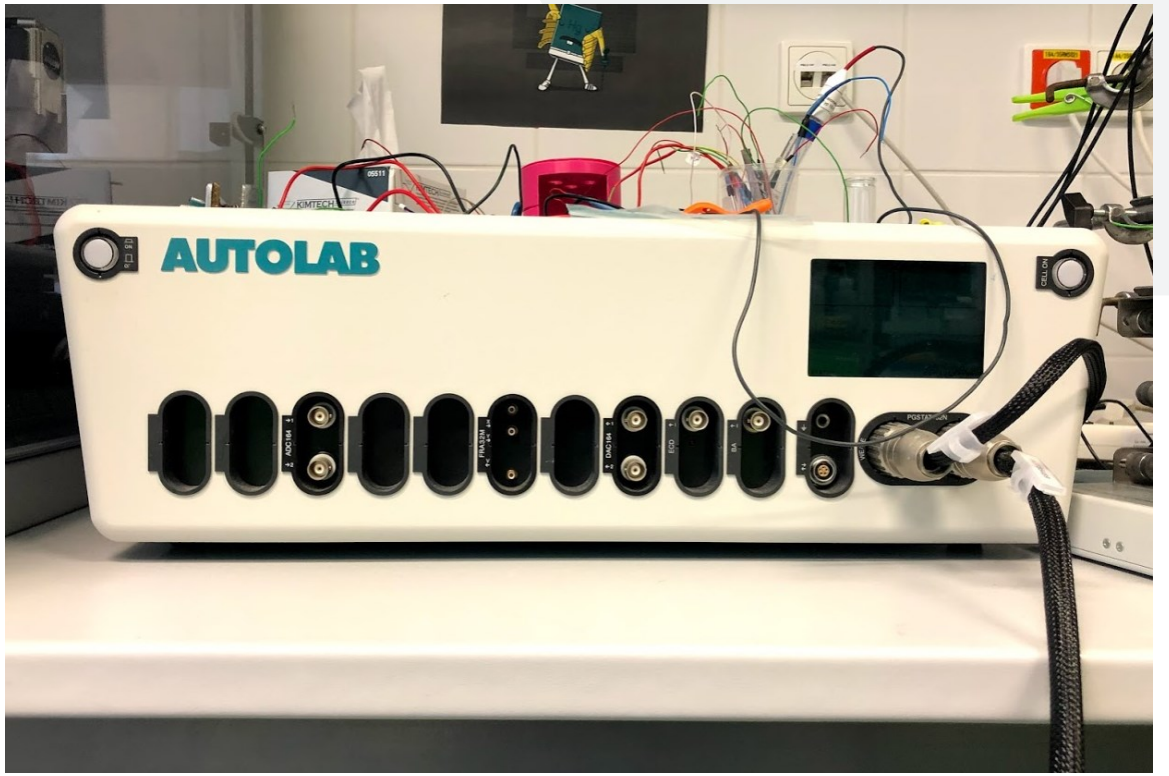


Autolab Modular potentiostat

MultiChannel MEA2100Lite





CF NanoBio

Technology and Expertise

Technology and Expertise
List of services

1. **Cells – mechanical properties**
2. **Cells - imaging**
3. **Biomolecules - imaging**
4. **Nano-objects imaging**
5. **Raman-AFM combined microscopy**
6. **Raman microscopy**
7. **Electrochemical measurements**
8. **Nanodeposition system**
9. **SPR biosensor**
10. **Scanning of upconversion luminescence**
11. **Multielectrode array recording of cellular potential**

FULL SERVICE / MEASUREMENT only / DATA PROCESSING only

CF NanoBio

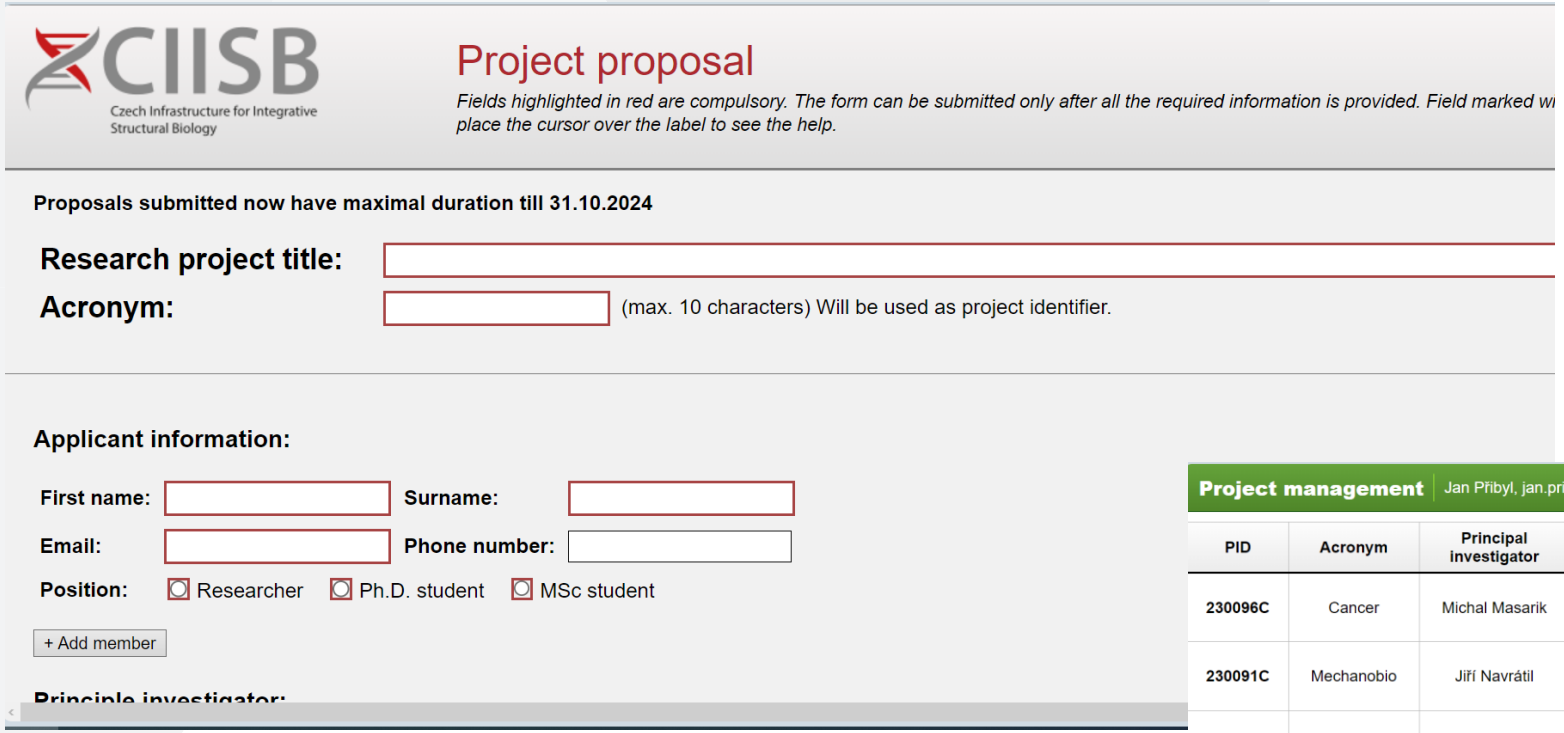
Administrative background

CIISB Project applications, 2021

- **CIISB projects** submitted to https://stigmator.ceitec.muni.cz)
- Total number **26 projects**
- **7** from **CEITEC MU**
- **5** from **CEITEC BUT**
- **2** from **foreign institutions**.

- **Cell mechanobiology 10**
- **Tissue mechanobiology 4**
- **Cellular electrophysiology 1**
- **Raman microscopy mapping 3**
- **Biomolecules imaging 5**
- **Nano-objects imaging 5**
- **Some projects combined**

CIISB project



CIISB
Czech Infrastructure for Integrative Structural Biology

Project proposal

Fields highlighted in red are compulsory. The form can be submitted only after all the required information is provided. Field marked w
place the cursor over the label to see the help.

Proposals submitted now have maximal duration till 31.10.2024

Research project title:

Acronym: (max. 10 characters) Will be used as project identifier.

Applicant information:

First name: **Surname:**

Email: **Phone number:**

Position: Researcher Ph.D. student MSc student

+ Add member

Principle investigator:

- 10% of costs covered by users
- Project submission and reviewing
- Acknowledgment.

Project management | Jan Přibyl, jan.pribyl@ceitec.muni.cz, CF Nanobio

PID	Acronym	Principal investigator	Proposal	Technical feasibility	Peer-review	Project status
230096C	Cancer	Michal Masarik	View | PDF	■ CF Nanobio | View | PDF	not required	Service in progress Finish servic
230091C	Mechanobio	Jiří Navrátil	View | PDF	■ CF Nanobio | View | PDF	not required	Service in progress Finish servic
230087C	pep-mem	Robert Vacha	View | PDF	■ CF BIC ■ CF CryoEM ■ CF Nanobio | View | PDF ■ CF Prot	not required	Service in progress Finish servic
230086C	DivIVA	Imrich Barák	View | PDF	■ CF CryoEM ■ CF Nanobio | View | PDF	not required	Service in progress Finish servic
230085C	RAD51FIL	Lumir Krejci	View | PDF	■ CF CryoEM ■ CF Nanobio | View | PDF	not required	Service in progress Finish servic
230078C	Stau	Peter Josef Lukavsky	View | PDF	■ CF Nanobio | View | PDF	not required	Service in progress Finish servic

Impacted Publications

- The main objective of the Core Facility - help them produce scientific results publishable in the impacted journals
- **2019 – 2020**: **33 papers** with the Acknowledgement to CF Nanobio
- Complete list in the Report SI
- Selected papers:

1. RAUDENSKÁ, Martina, Monika KRATOCHVÍLOVÁ, Tomáš VIČAR, Jaromír GUMULEC, Jan BALVAN, Hana POLANSKÁ, Jan PŘIBYL a Michal MASAŘÍK. Cisplatin enhances cell stiffness and decreases invasiveness rate in prostate cancer cells by actin accumulation. Scientific reports, London: NATURE PUBLISHING GROUP, 2019, roč. 9, č. 1660, s. 1-11. ISSN 2045-2322. doi:10.1038/s41598-018-38199-7.
2. CALUORI, Guido, Jan PŘIBYL, Martin PEŠL, Šárka JELÍNKOVÁ, Vladimír ROTREKL, Petr SKLÁDAL a Roberto RAITERI. Non-invasive electromechanical cell-based biosensors for improved investigation of 3D cardiac models. Biosensors & bioelectronics : the international journal for the professional involved with research, technology and applications of biosensors and related devices, Elsevier Science, 2019, roč. 124, JAN 15 2019, s. 129-135. ISSN 0956-5663. doi:10.1016/j.bios.2018.10.021.
3. Cernochova, P.; Blahova, L.; Medalova, J.; Necas, D.; Michlicek, M.; Kaushik, P.; Pribyl, J.; Bartosikova, J.; Manakhov, A.; Bacakova, L.; Zajickova, L., Cell type specific adhesion to surfaces functionalised by amine plasma polymers. Sci Rep 2020, 10 (1), 14.
4. Laidou, S.; Alanis-Lobato, G.; Pribyl, J.; Rasko, T.; Tichy, B.; Mikulasek, K.; Tsagiopoulou, M.; Oppelt, J.; Kastrinaki, G.; Lefaki, M.; Singh, M.; Zink, A.; Chondrogianni, N.; Psomopoulos, F.; Prigione, A.; Ivics, Z.; Pospisilova, S.; Skladal, P.; Izsvak, Z.; Andrade-Navarro, M. A.; Petrakis, S., Nuclear inclusions of pathogenic ataxin-1 induce oxidative stress and perturb the protein synthesis machinery. Redox Biology 2020, 32.
5. 9. SADZAK, A., J. MRAVLJAK, N. MALTAR-STRMECKI, Z. ARSOV, G. BARANOVIC, I. ERCEG, M. KRIECHBAUM, V. STRASSER, Jan PŘIBYL a S. SEGOTA. The Structural Integrity of the Model Lipid Membrane during Induced Lipid Peroxidation: The Role of Flavonols in the Inhibition of Lipid Peroxidation. Antioxidants. Basel: MDPI, 2020, roč. 9, č. 5, s. 430-457. ISSN 2076-3921. doi:10.3390/antiox9050430.

User Training

- 2019 – 2021: **6 workshops**
- **Over 200 participants**
- Workshop content shared **online** – youtube, Data Storage

Workshop title	Date	Main objectives	No of participants
Atomic Force Microscopy (AFM) for Bio Applications	April 16-17, 2019	Combined characterization of biosamples by AFM, practical applications, hands-on session	20
Characterization of nanoparticles and proteins by Atomic Force Microscopy	July 30-31, 2019	Characterization of nano-objects and proteins by AFM, practical applications, hands-on session	25
Spring Workshop on BioAFM Microscopy	April 6-8, 2020	Theoretical background and new aspects of bio-AFM microscopy, sample preparation, hands-on session, social event	Canceled
Introduction to Raman microscope Renishaw inVia	June 23rd, 2020	Introducing the Raman microscope Renishaw inVia, User samples characterization	12
(Bio) Atomic Force Microscopy (bioAFM), Basic Course	October 1st, 2020	Basics of AFM, Sample preparation techniques, Data processing	80
Introduction to JPK NanoWizard 4 AFM microscope	May 4th, 2021	Introduction to a new JPK NanoWizard AFM system combined with CytoSurge and NanoIndentor module	10

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instruct
Integrating
Biology

LM2023042

CIISB
Czech Infrastructure for Integrative Structural Biology

MŠMT

Cytoplasmic live-cell biopsies for the temporal profiling of single-cells

Go beyond in single cell manipulation

Gentle and accurate single-cell injection and cytoplasmic biopsies

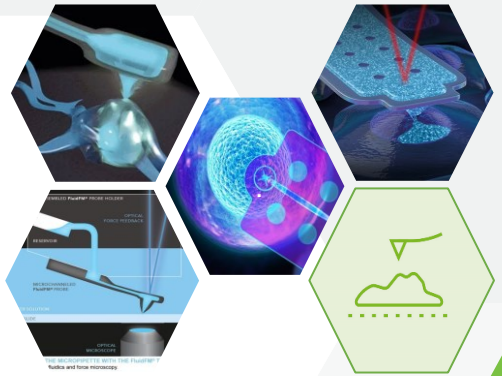
Fluidic force microscopy, or **FluidFM** is a biophysical technique for conducting **single-cell biopsies**. This innovative approach enables the extraction of a part of the cytoplasm from individual living cells while preserving their viability.

These cytoplasmic biopsies can be used for subsequent highly-sensitive, low-input **RNA-seq analysis** to characterize **single cells multiple times** throughout their lifetime.

Moreover, the **FluidFM Nanosyringes** extend their utility by facilitating the **targeted introduction** of various molecular components into cells, including **RNA**, **DNA**, proteins, and even molecular complexes such as **CRISPR/Cas9 RNPs**.

This functionality streamlines the transfection processes for plasmids and transcription factors and enables entire cell line engineering workflows.

By exploring the capabilities of **FluidFM** in this seminar, we seek to uncover its **potential implications** for advancing the comprehension of intricate cellular processes, thus fostering new dimensions in **cellular analysis** and **molecular investigation.**



Register here

CYTOSURGE®

FluidFM®

October 18th 2023

University Campus Bohunice
Brno, Czech Republic
*building **E35**, room **145***

Core Facility Nanobiotechnology
CEITEC MU, Masaryk university
Kamenice 5 , Brno, Czech Republic

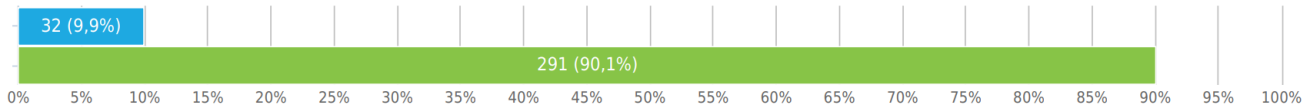
jan.pribyl@ceitec.muni.cz
Web: www.ceitec.eu/nanobio

User Survey

173. Have you used Nanobiotechnology (Nanobio) core facility?

Výběr z možností, zodpovězeno 323x, nezodpovězeno 0x

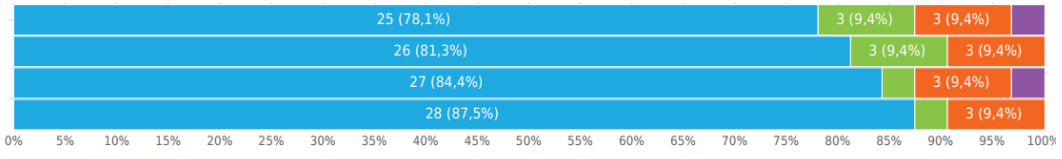
Možnosti odpovědí	Responzí	Podíl
Yes	32	9,9 %
No	291	90,1 %



175. Service quality: How satisfied are you with service quality at Nanobio?

Matice výběru z možností, zodpovězeno 32x, nezodpovězeno 291x

Odpověď	1	2	3	4	5	Not applicable/can not answer
Ease of access (clear presentation of services, prices and access modalities)	25 (78,1 %)	3 (9,4 %)	0	0	3 (9,4 %)	1 (3,1 %)
Project specific support (core facility is willing and able to provide detailed guidance and additional support on top of the standard services)	26 (81,3 %)	3 (9,4 %)	0	0	3 (9,4 %)	0
Expertise of the core facility staff	27 (84,4 %)	1 (3,1 %)	0	0	3 (9,4 %)	1 (3,1 %)
Professional and friendly service (I feel welcome when contacting core facility staff, I get quick and competent answers to my questions and requests)	28 (87,5 %)	1 (3,1 %)	0	0	3 (9,4 %)	0



176. Do you have any comments about service quality?

Textová odpověď, zodpovězeno 13x, nezodpovězeno 310x

- CF personel is underestimated
- Everything ok.
- OK
- excellent
- No
- I especially welcome help with adjustment of measurement parameters
- Staff is always willing to help, experts in their fields.
- prompt measurement but until now no results processed
- Dr Pribyl has excellent knowledge not only in AFM area
- Excellent service, facility is willing to help with anything needed. Always available for your questions.
- Jan Pribyl was a great help during our intense measurements on AFM NanoWizard 3.
- (2x) no

- N/A
- 20 samples per month
- Possibly some software for volumetric analysis
- pink gloves
- Nanoparticle characterization, stability studies - DLS, zeta-potential. On a regular basis..
- no idea
- Nap room, so that the short stay of AFM measurement would allow more data measured by the visitor, into very late hours and with short periods of sleep
- -
- no

Technology offers for industrial partners

Cooperation with industrial partners (http://industry.ceitec.cz/), Daniela Tršová manages this topic.

Bio-AFM microscopy imaging and biomechanical studies

AFM microscopy (structure and mechanical properties) of bio-samples (biomolecules, cells, tissues) under semi-physiological conditions (37 ^{o}C, liquid media).

- **Raman microscopy of biosamples**

  Raman mapping of biosamples (molecular complexes, cells, tissues) with high resolution (~ 500 nm)

- **Drug testing on cardiac cells**

  Biomechanical (bioAFM) and electrical field potential signal as a response to drug exposition. Human stem cells and/or primary animal cells can be used. *! Coordination with Vladimir Rotrekl RG – essential!!!*

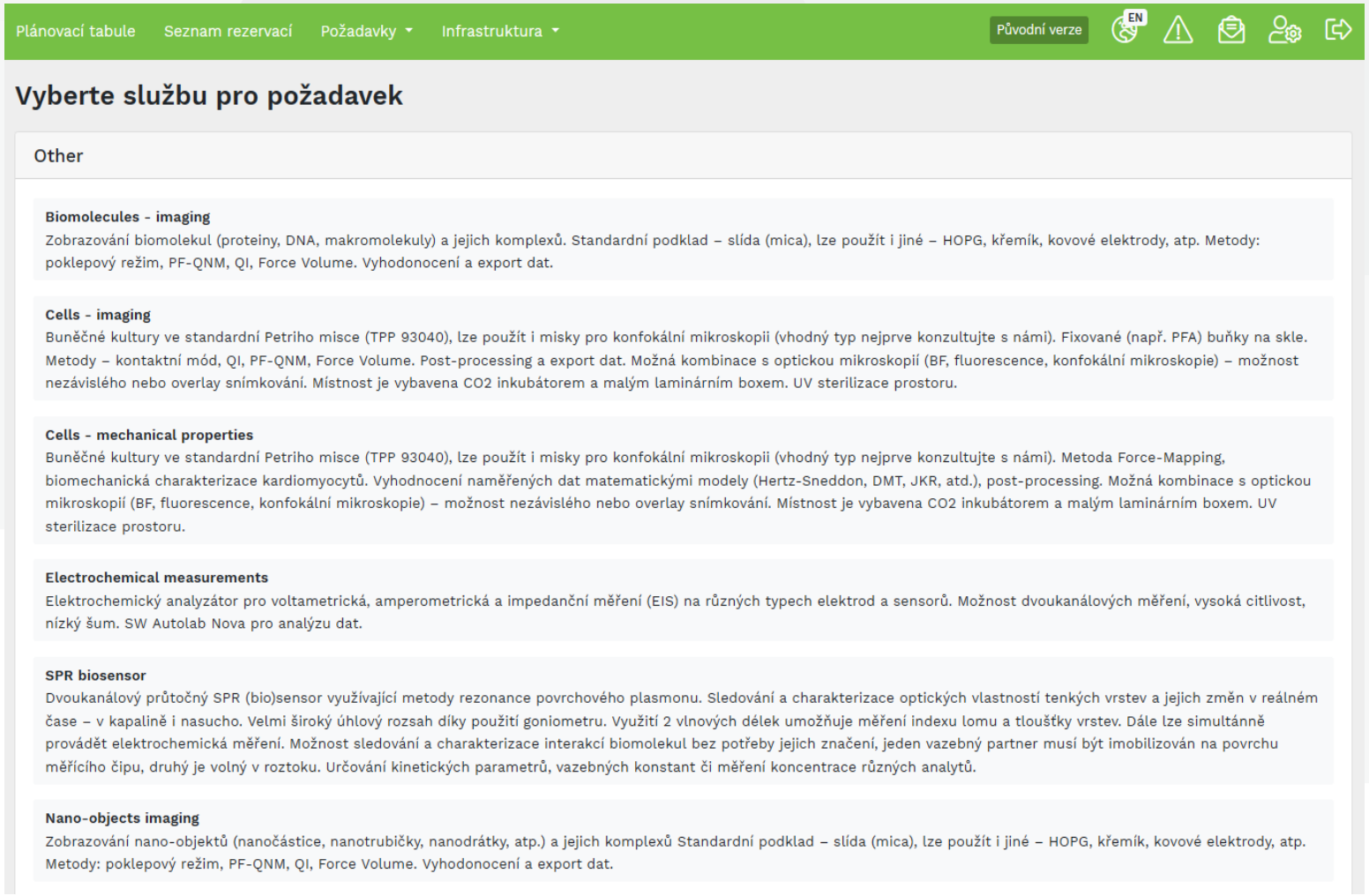
- **Tuneable hydrogel system**

  The new system of stable and Robust biocompatible hydrogel system with tunable mechanical properties.

  ! Coordination with Vladimir Rotrekl RG – essential!!!

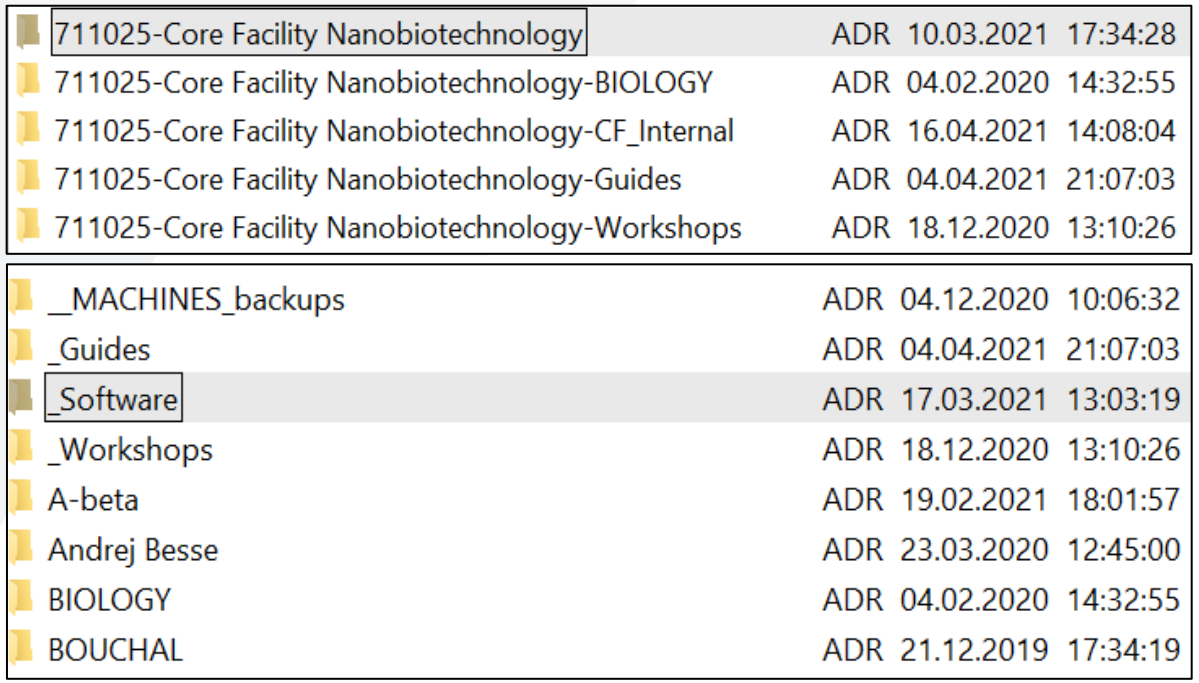
Booking system

Under development for last 2 years..



Data Sharing

- Medium Storage of MU – complicated for external users
- OneDrive – limited space to 1 TB
- IT manager missing



Sharing of

- *Data*
- *Workshop content*
- *Software*
- *Guides*

Impacted Publications

- The main objective of the Core Facility - help them produce scientific results publishable in the impacted journals
- **15 – 20 impacted publications per year (CF acknowledgement)**

Grants received

Project name	Provided by	Period
CIISB Large infrastructure project	MEYS	2016 - 2022
OP VVV – CIISB4Health	MEYS	2017 - 2021
OP VVV – UP CIISB	MEYS	2020 - 2022
Long-life education	MU	2021
RIAT-CZ	Interreg	2016 - 2020

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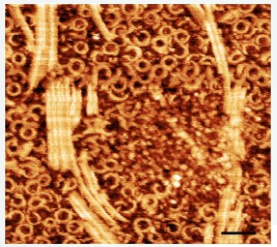
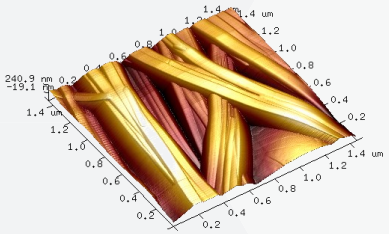
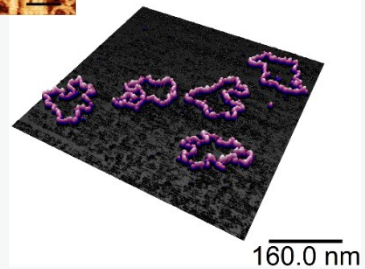
CF NanoBio - Applications

AFM microscopy / spectroscopy

imaging

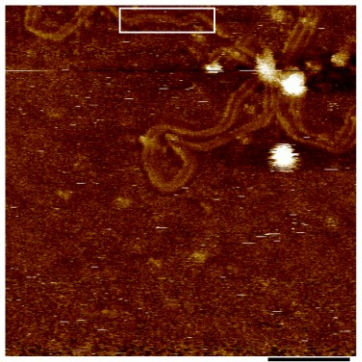


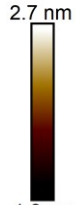


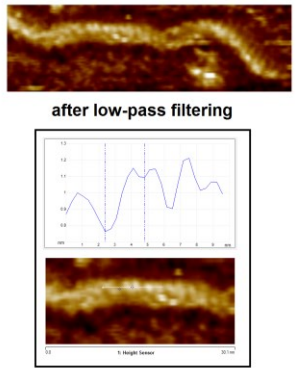


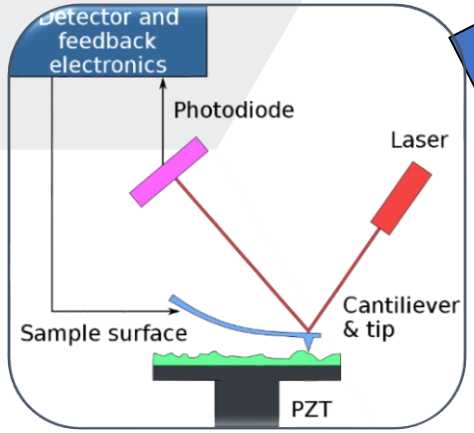
Protein, DNA molecules

Nanoobjects

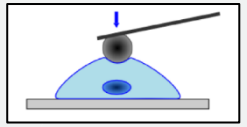


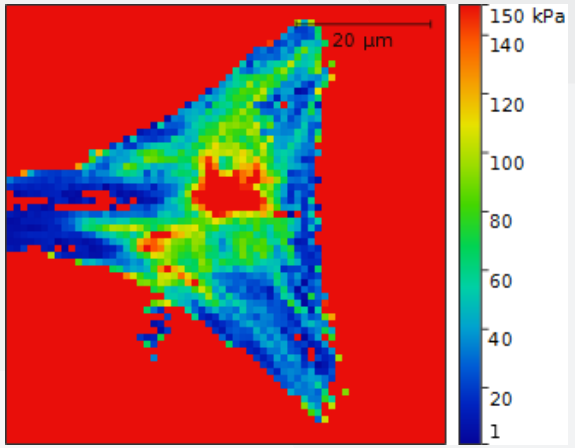


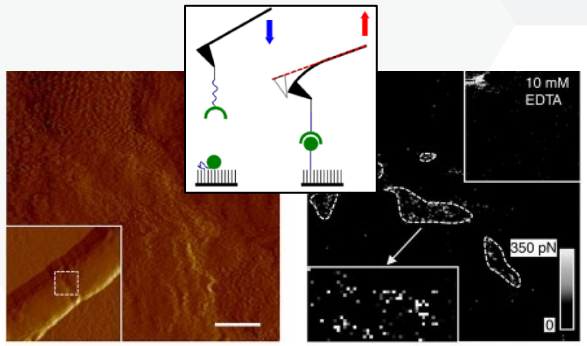




Stiffness mapping (nanoindentation)







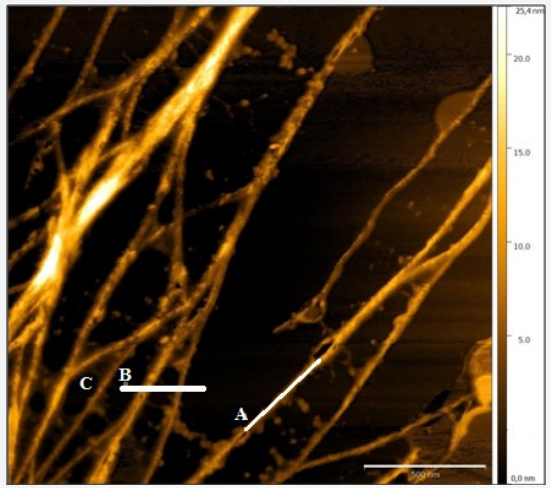
Affinity interaction

+ FluidFM

+ NanoIndentor

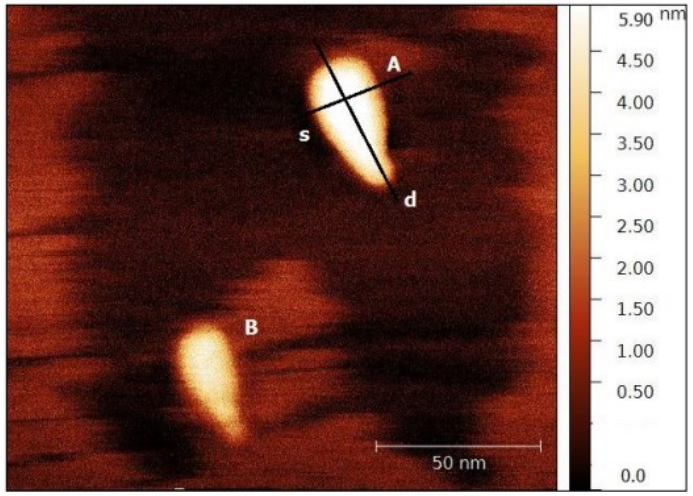
AFM schematics by OverloardQ

Molecular imaging and biomechanics



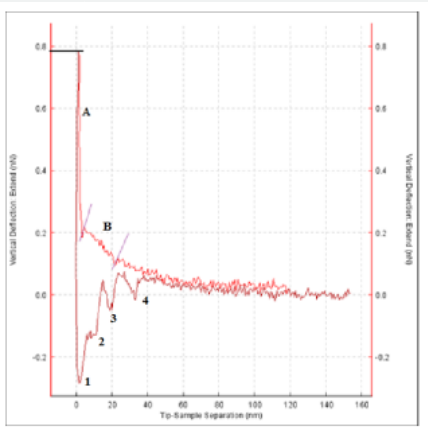
hyaluronan

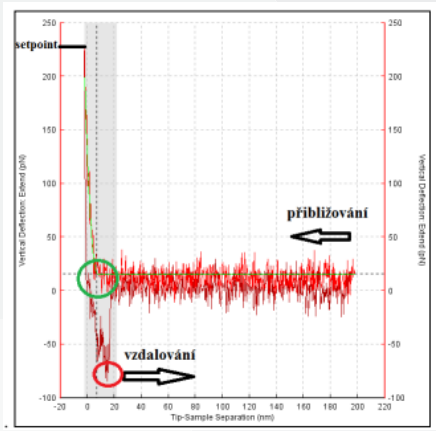
+



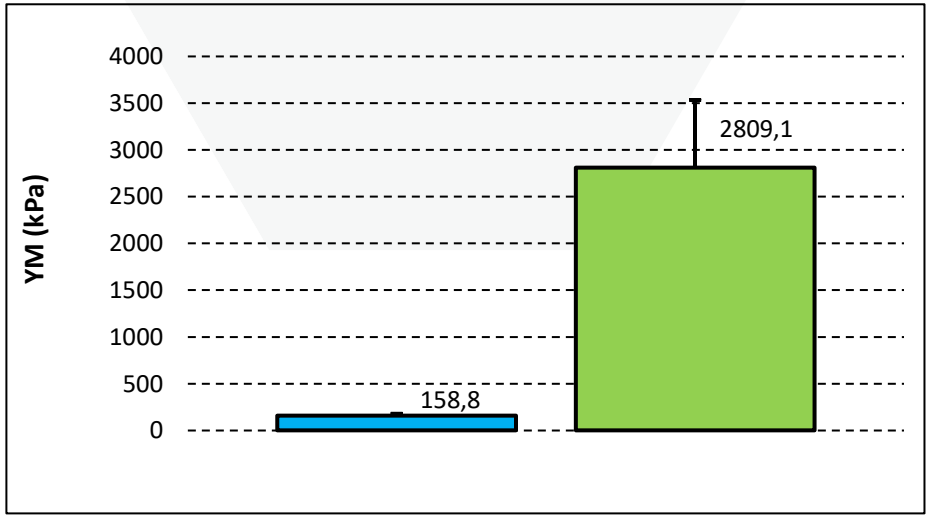
myeloperoxidase

FD-curve analysis

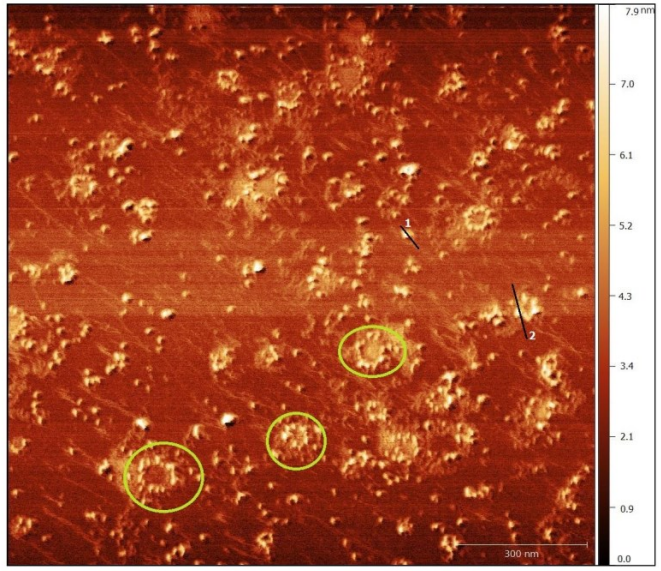




HA-MPO complex is 20x stiffer comparing to HA



Structure of the complex



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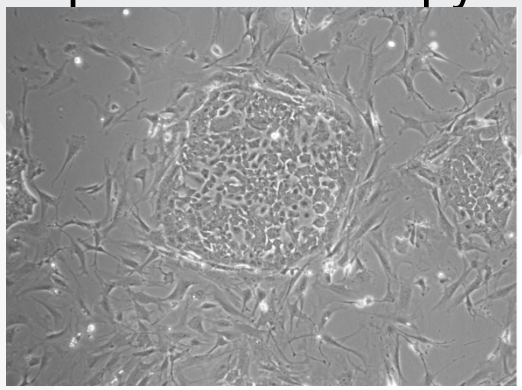
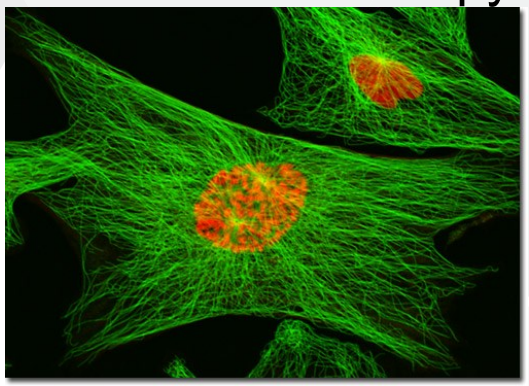
Nanomechanical mapping of living cells

Motivation

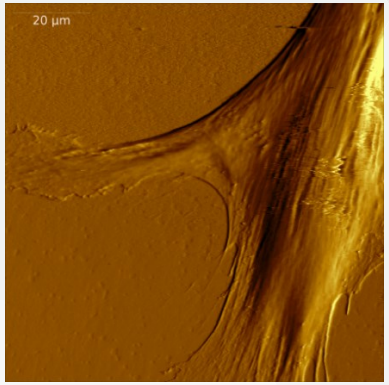
Optical microscopy

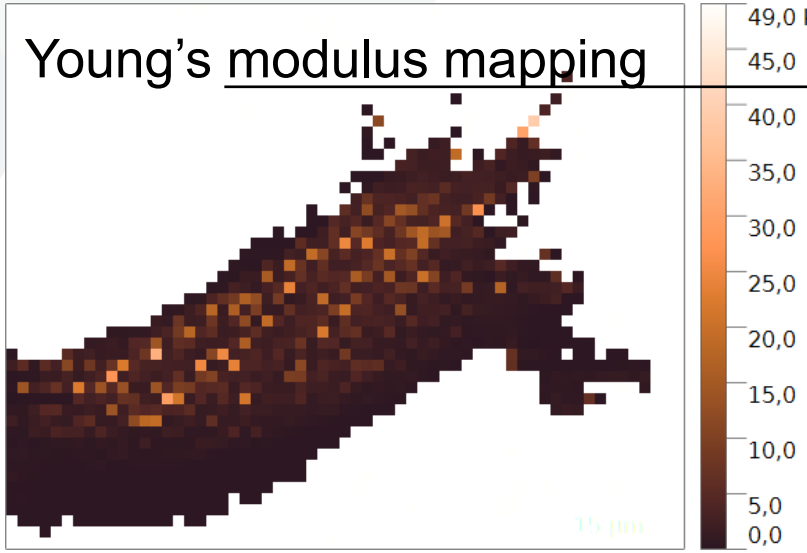


Confocal microscopy



AFM





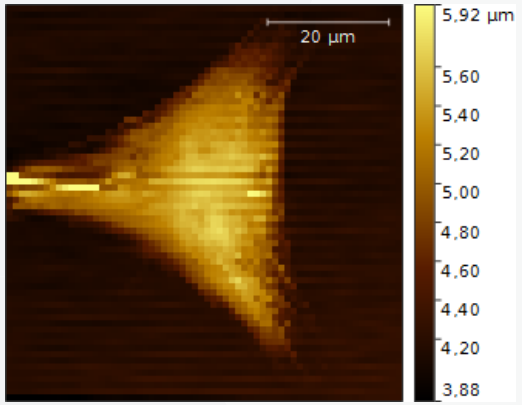
Motivation

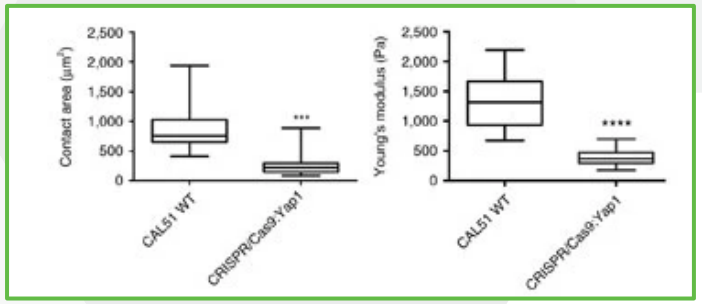
Why to quantify elasticity of (living) objects?

- **Stiffness** (Young's modulus) **mapping**
  → stiffness = basic parameter of any material
- **Elasticity-phenotype** relation ship
- **Mechanobiological** characterization
- **Driving of instrument** properties (QNM, QI)

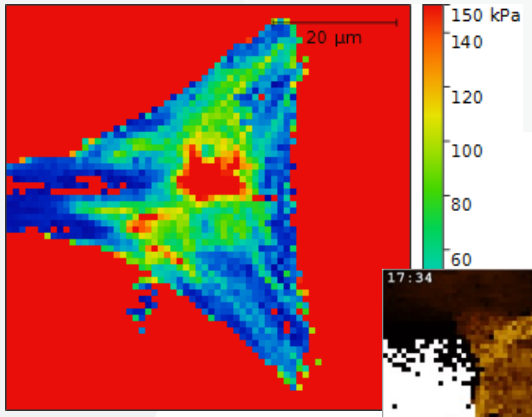
Cellular nanomechanics
By means of AFM

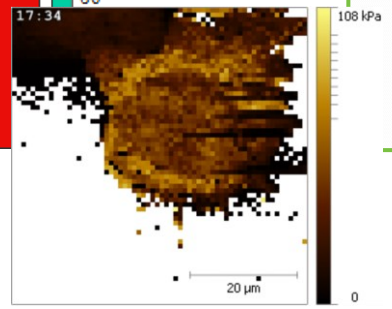
AFM mapping - correlation with fluorescence microscopy

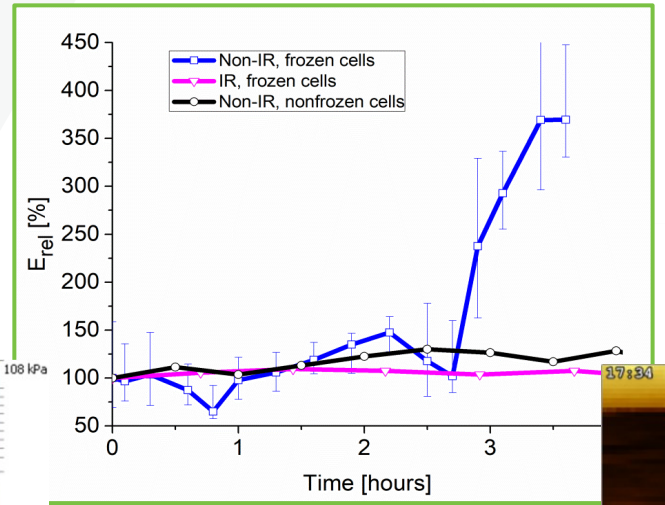




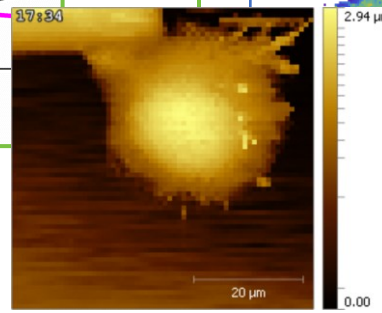
Evalutation - statistics

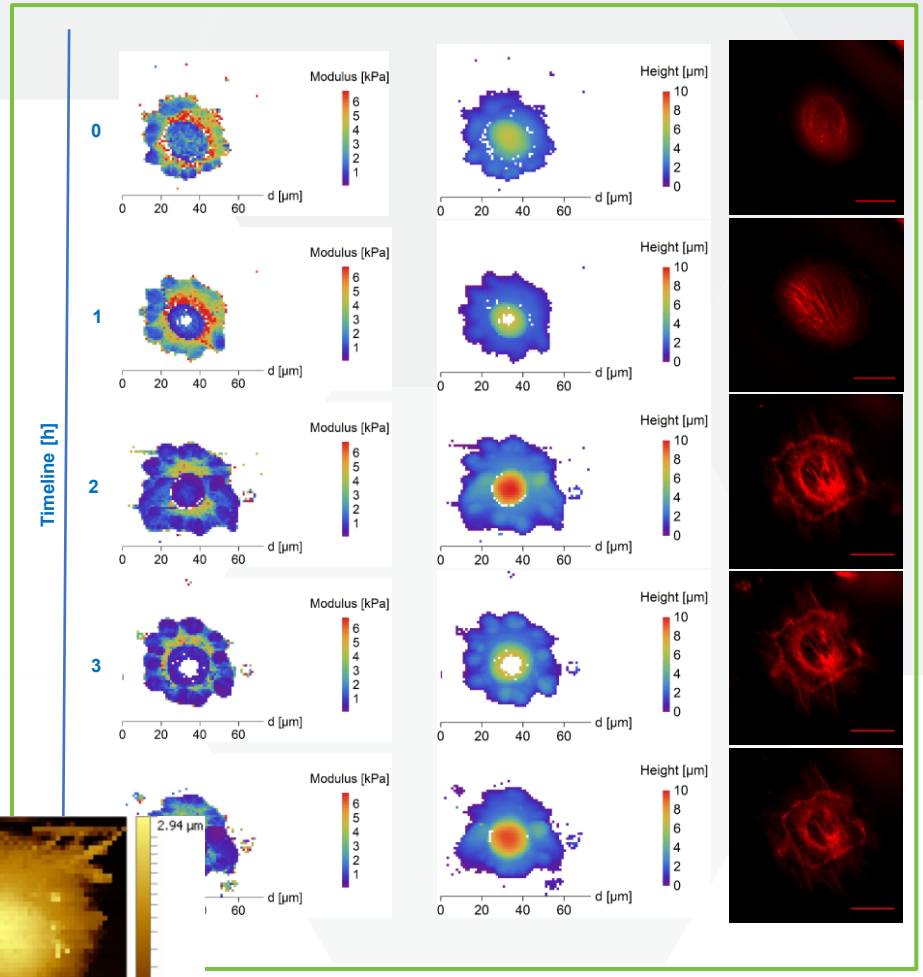






Time-lapsed biomechanics

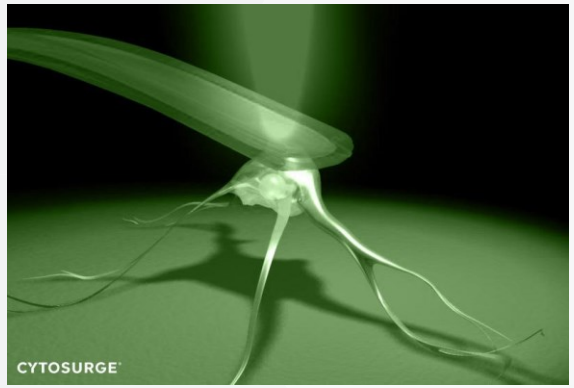


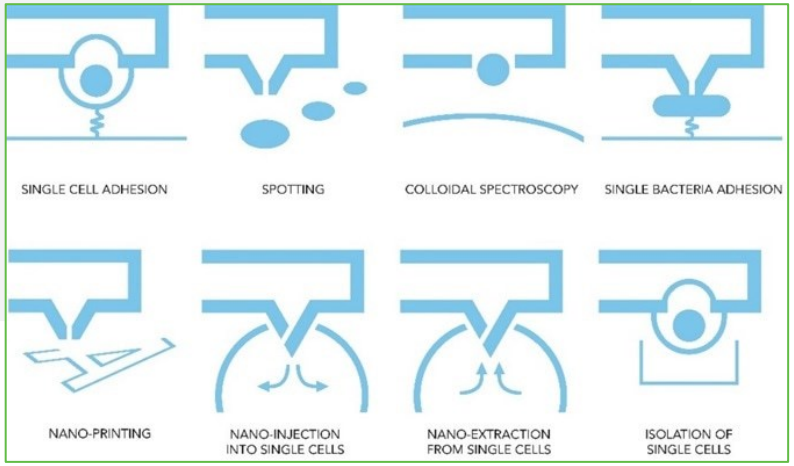


NARDONE, Giorgia, Jorge Oliver-De La CRUZ, Jan VRBSKY, Cecilia MARTINI, Jan PRIBYL, et al., 2017. YAP regulates cell mechanics by controlling focal adhesion assembly. *Nature Communications* [online]. **8**, ncomms15321.
GOLAN, Martin, et al. Front. Physiol., 29 June 2018

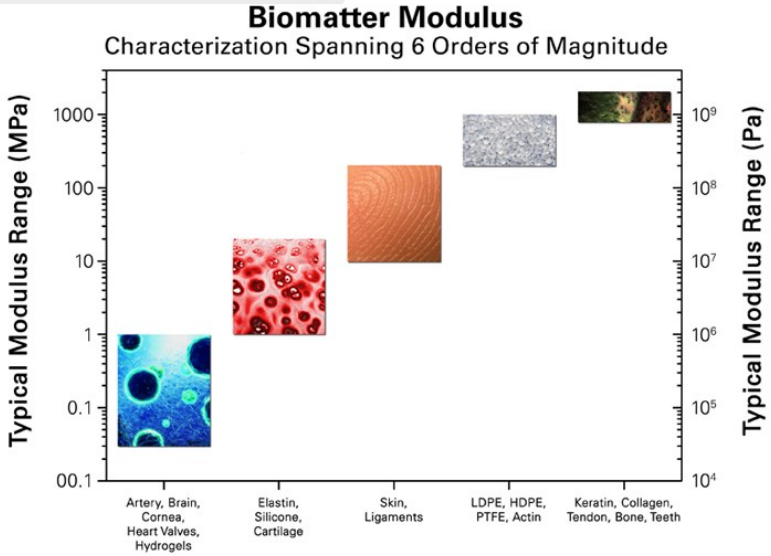
Combination with other techniques

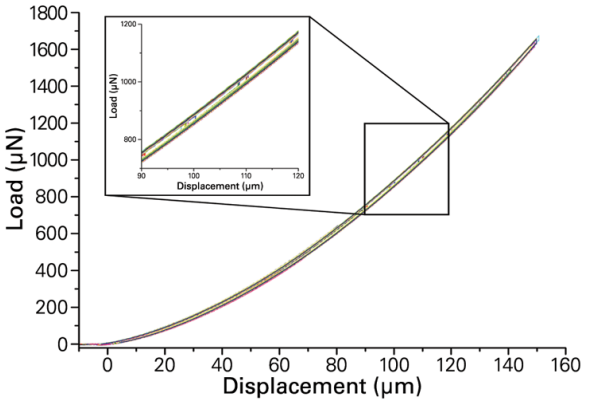
CytoSurge Fluid FM
module

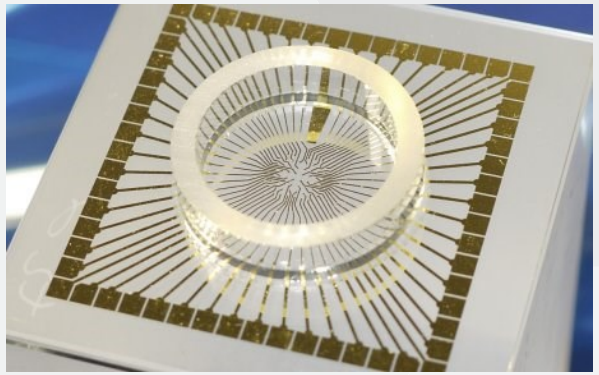




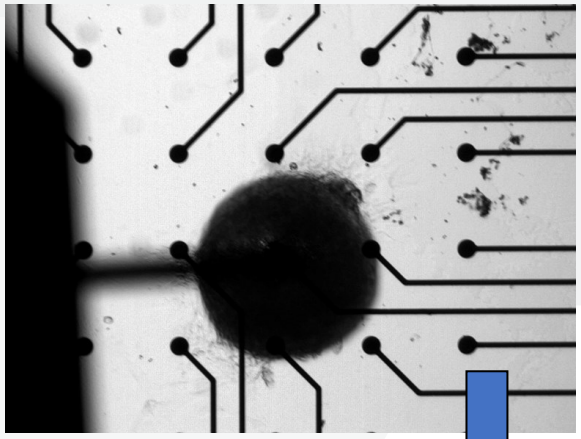
NanoIndentation
Single point indentation curves



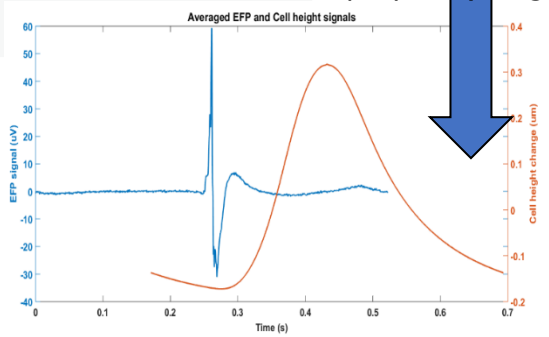




MultiElectrode Array
Extracellular Cell Potential
Cardiac cells and Neurons



AFM + MEA
= electromechanical (de)coupling



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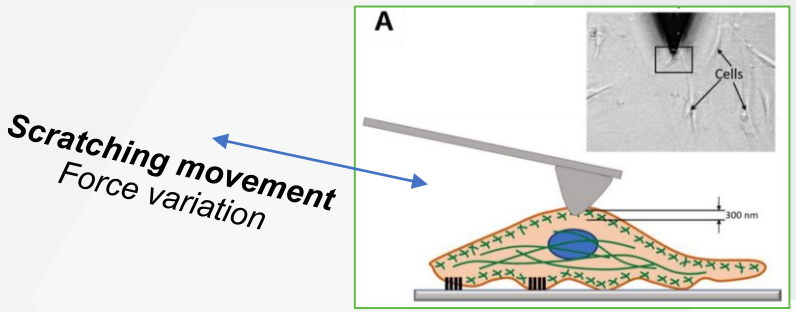
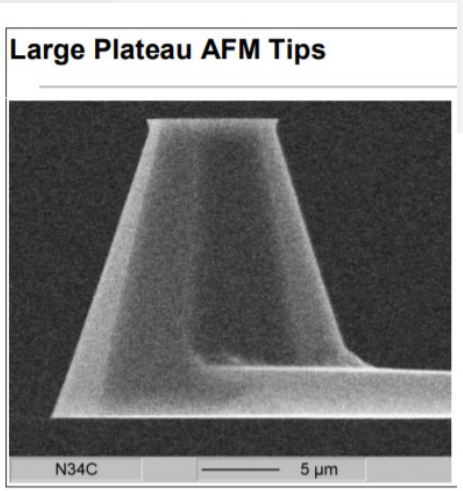
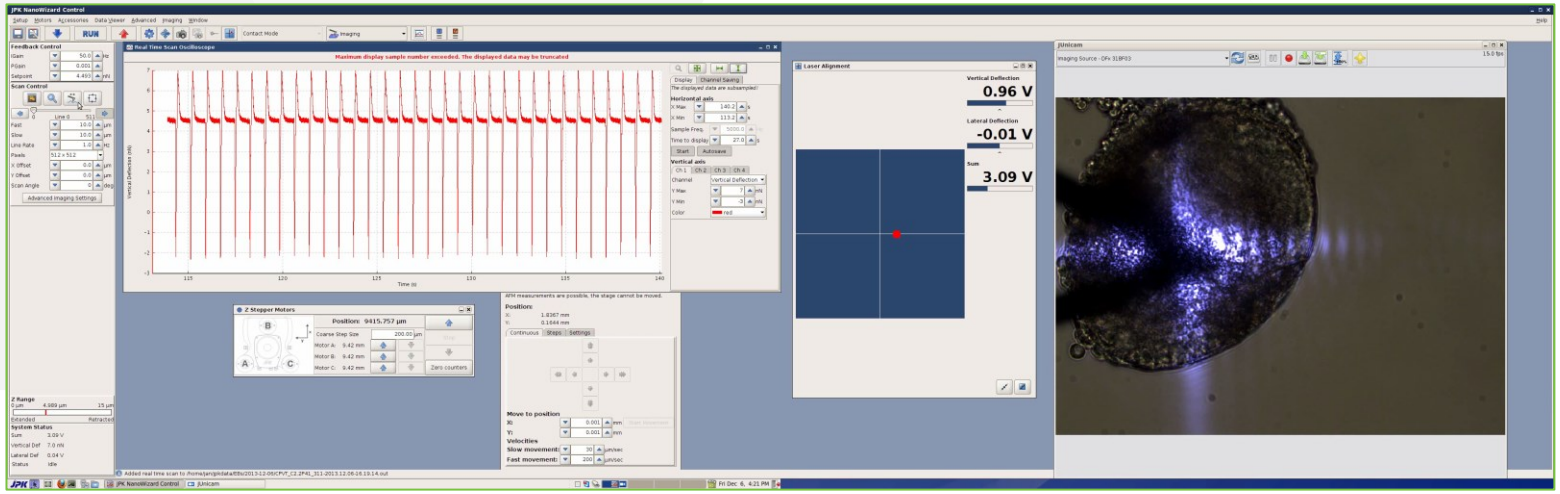
Other applications of AFM-based biomechanics

Cell scratching = cell adhesion

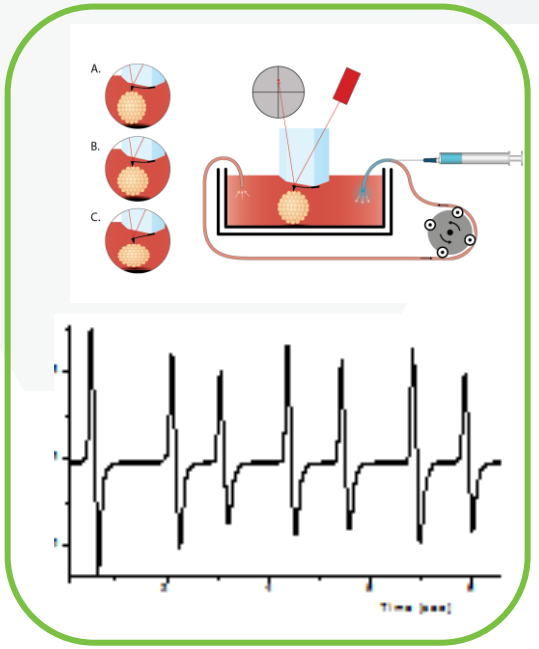




Cardiac cells biomechanics



Setup scheme



Pesl M, Pribyl J, et al. 2016 *Biosensors and Bioelectronics* **85** 751–7
Pesl M, Pribyl J, et al. 2016 J Mol Recognit n/a-n/a
Pesl M, Acimovic I, Pribyl J, et al. 2014 Heart Vessels 29 834–46

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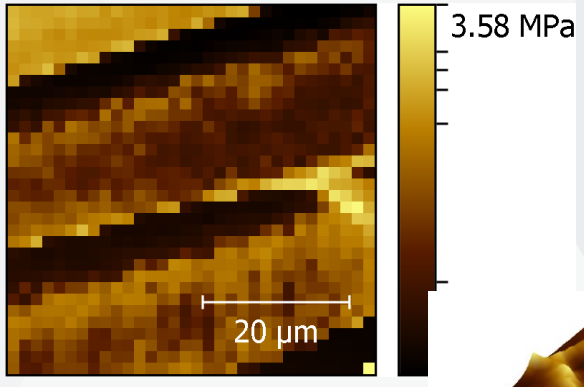
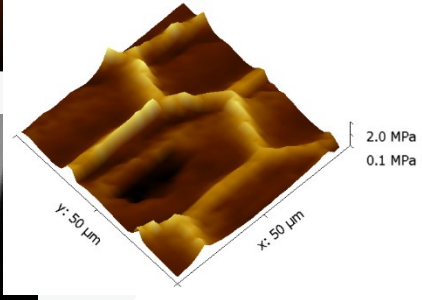
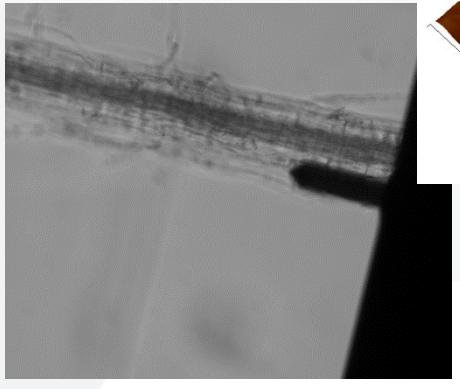
AFM-based biomechanics







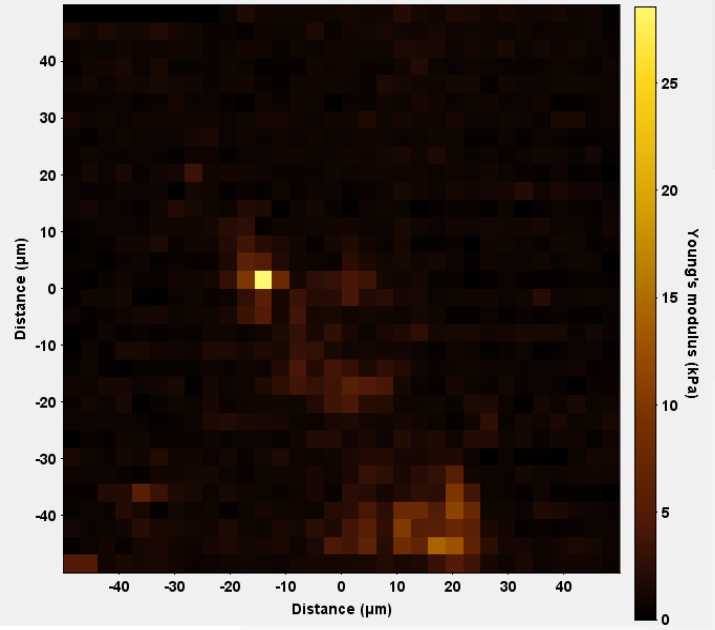
Plant samples

(hypocotyl)

by Marçal Gallemí

Eva Benkova Lab

& Jan Hejatko Lab

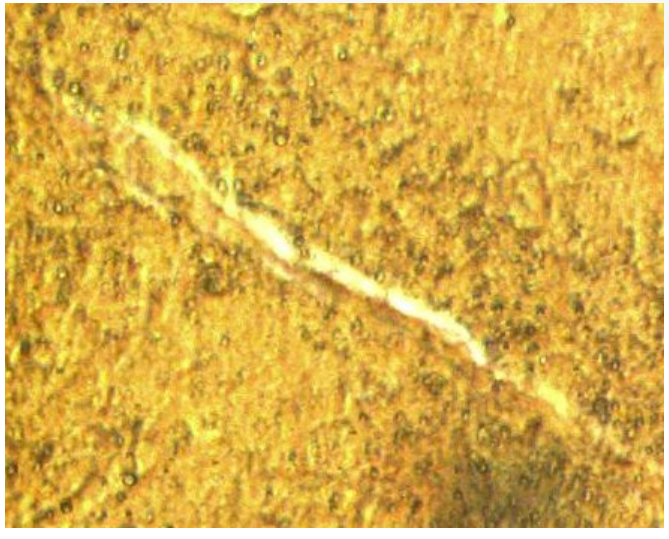


Liver cirrhosis

Correlation of

Collagen fibers by polarized microscopy

AFM nanoindentation

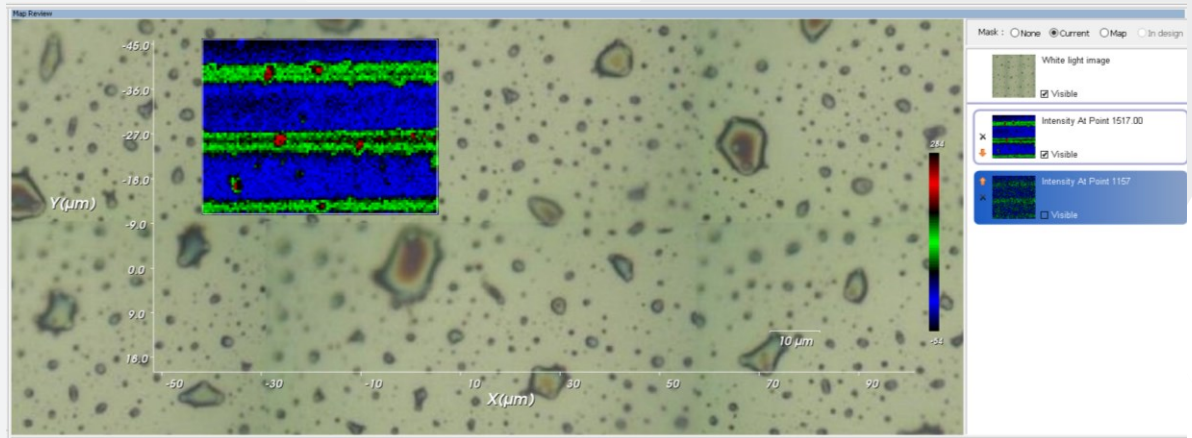


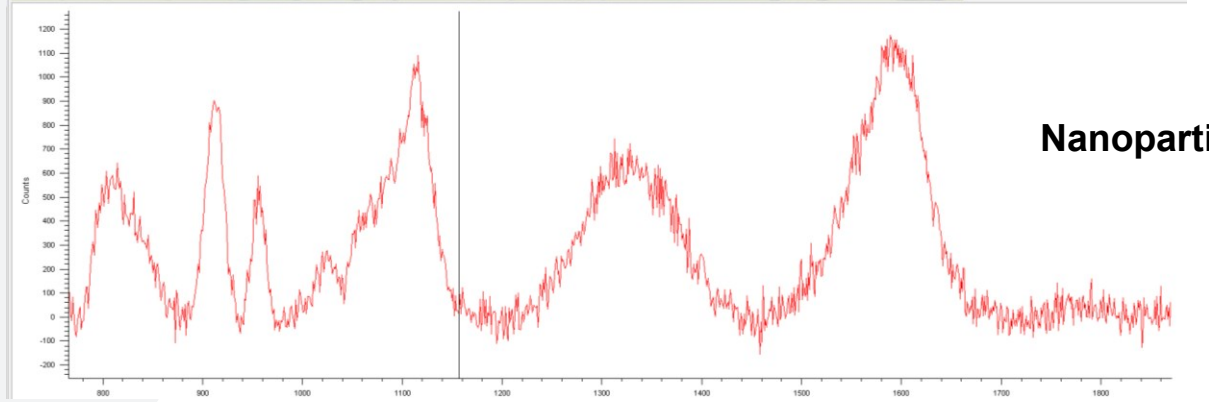
by Srikant Ojha

Martin Gregor Lab

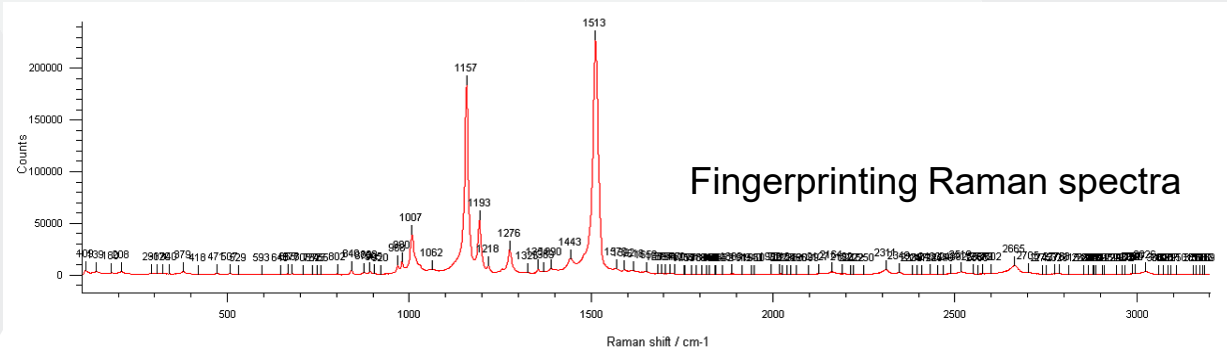
CEITEC

Raman microscopy
Chemical mapping



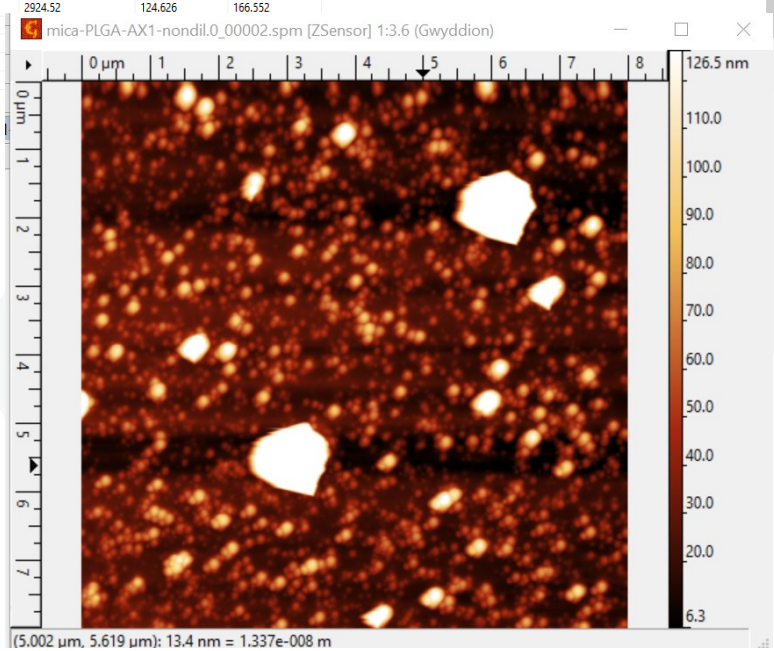


Nanoparticles loading study



Fingerprinting Raman spectra

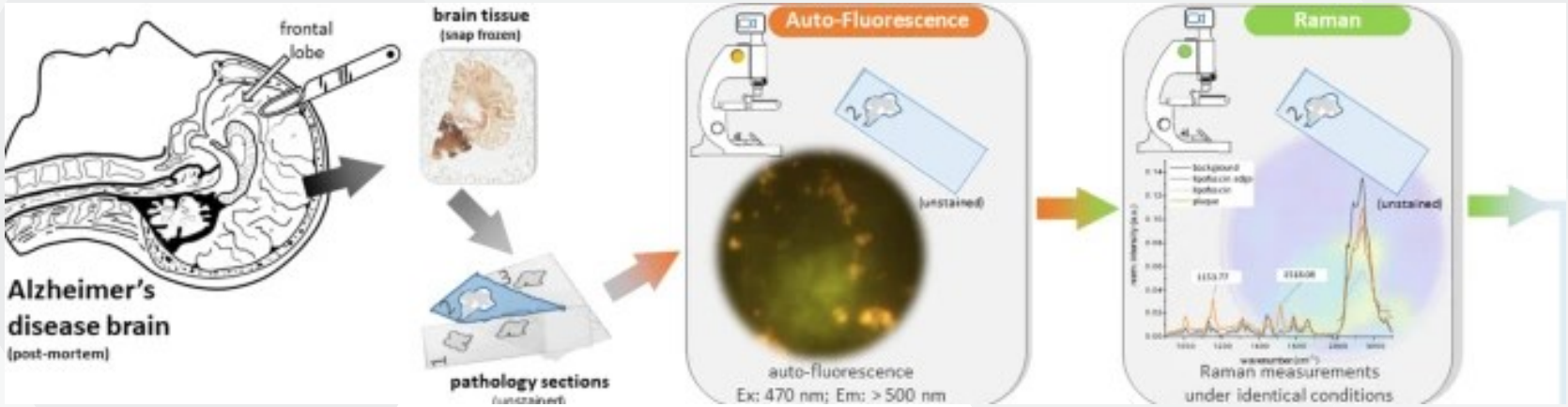
Peak no.	Centre	Height	Width	Area	Absolute intensity	Low edge	High edge
1	108.873	3059.03	9.28978	78556.2	4036.61	102.247	123.312
2	139.016	1668.17	14.5499	122921	2924.52	124.626	166.552
3	180.065	804.539	9.00485	55816.4			
4	208.109	1870.6	14.0121	110061			
5	291.483	692.559	7.83973	51650.1			
6	306.84	476.022	6.30329	31306.7			



+ combination with AFM topography

Raman microscopy
On bio samples

Lochocki, B., Boon, B.D.C., Verheul, S.R. *et al.* Multimodal, label-free fluorescence and Raman imaging of amyloid deposits in snap-frozen Alzheimer's disease human brain tissue. *Commun Biol* **4,** 474 (2021).



Raman imaging of **amyloid** deposits in snap-frozen **Alzheimer's disease** human brain tissue

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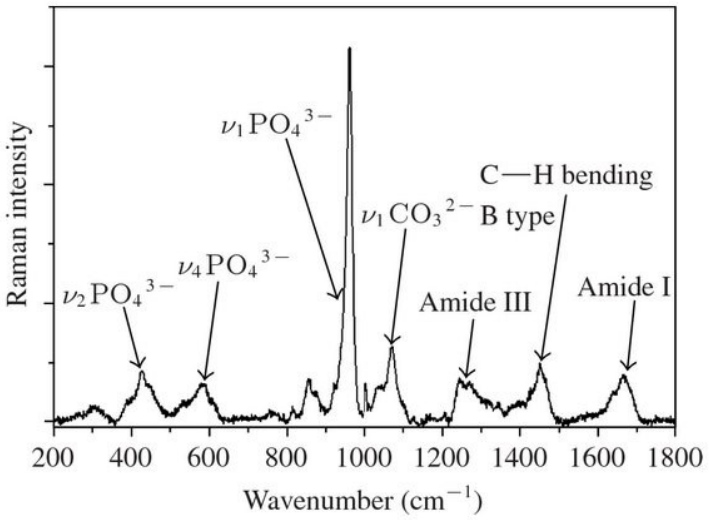
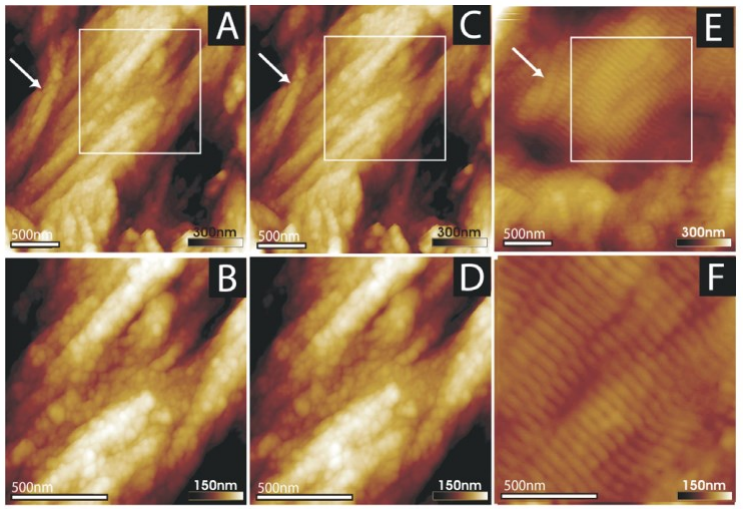
Calcification level and **Collagen Fibers** Arrangement in **Bone Tissue**



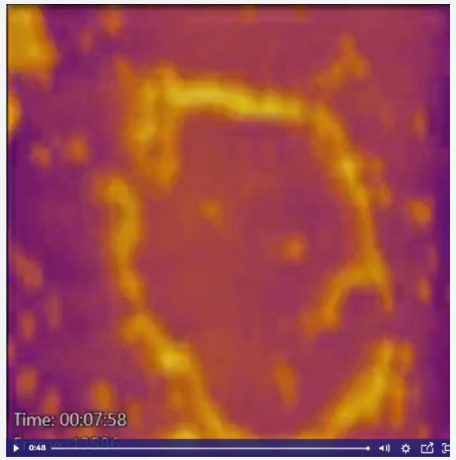


+ combination with AFM topography

Tomasz Buchwald, et al. Spectroscopy 27(2):107-117

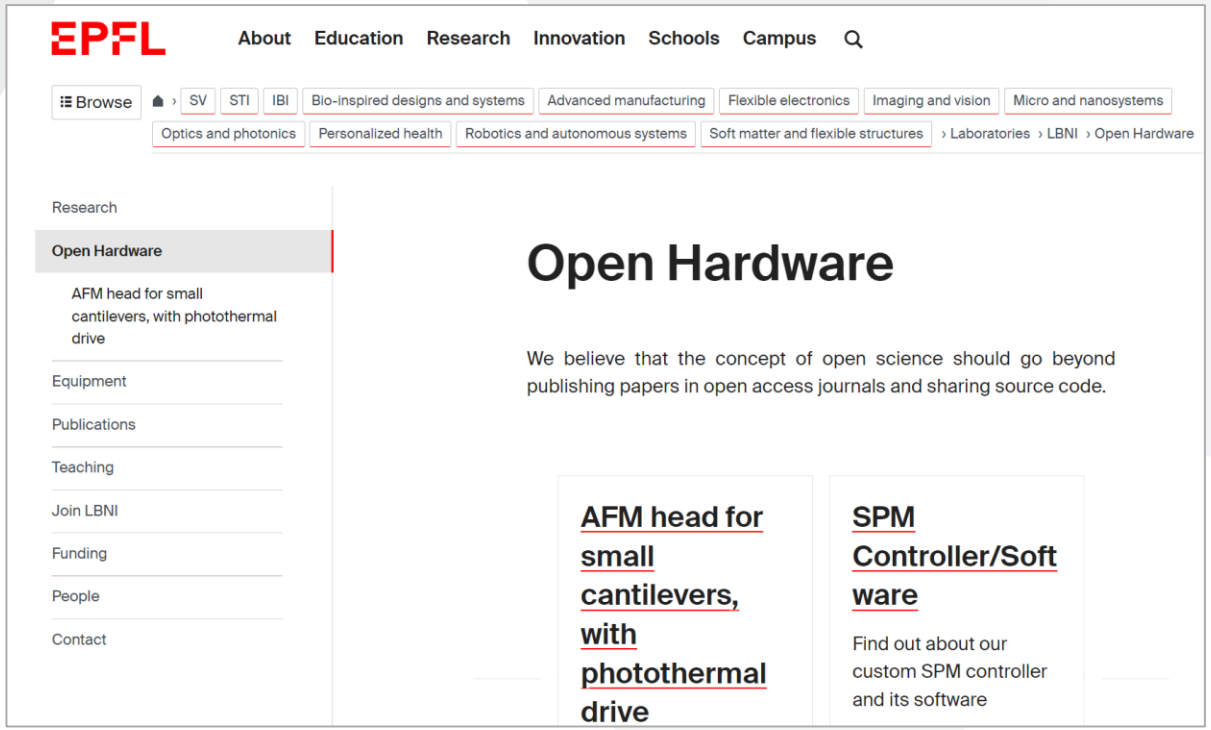
Where to go next...?

1. High-Speed (Video-Rate) AFM



Size: **425 nm**, line scan rate of **1250 lines/second**
160×32 pixels, (**28 fps**). The playback rate 10×
Source: https://afm.oxinst.com/Video-Rate-AFM-Movies?wvideo=abneb64e3y

Bruker MultiMode 8HR upgrade



https://www.epfl.ch/labs/lbni/openhardware/

Price 65 tEUR

Asylum Cypher VRS1250

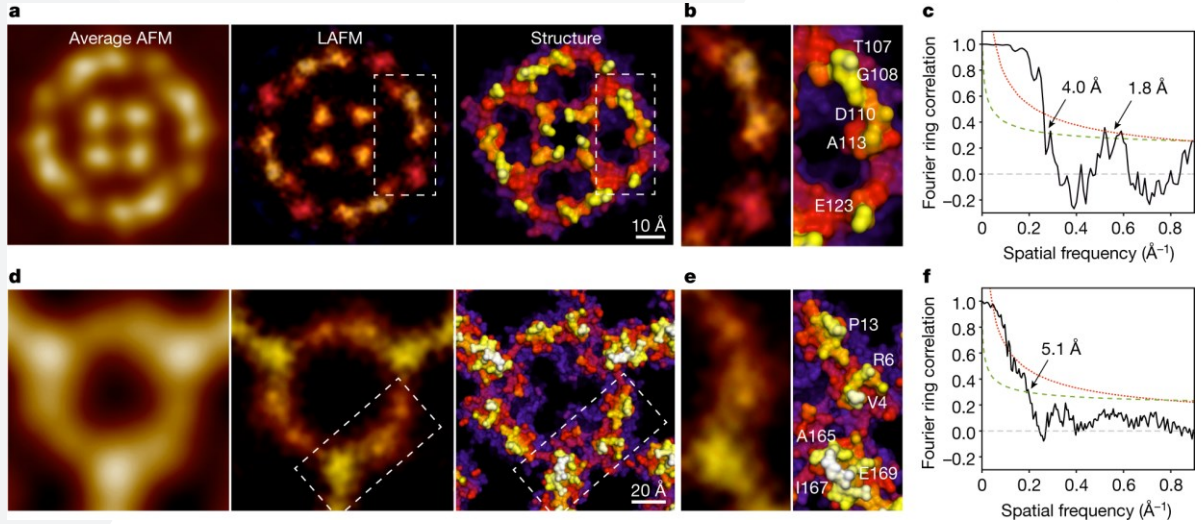
Video-Rate High-Speed AFM

Prices from 500 tEUR

Advanced data processing

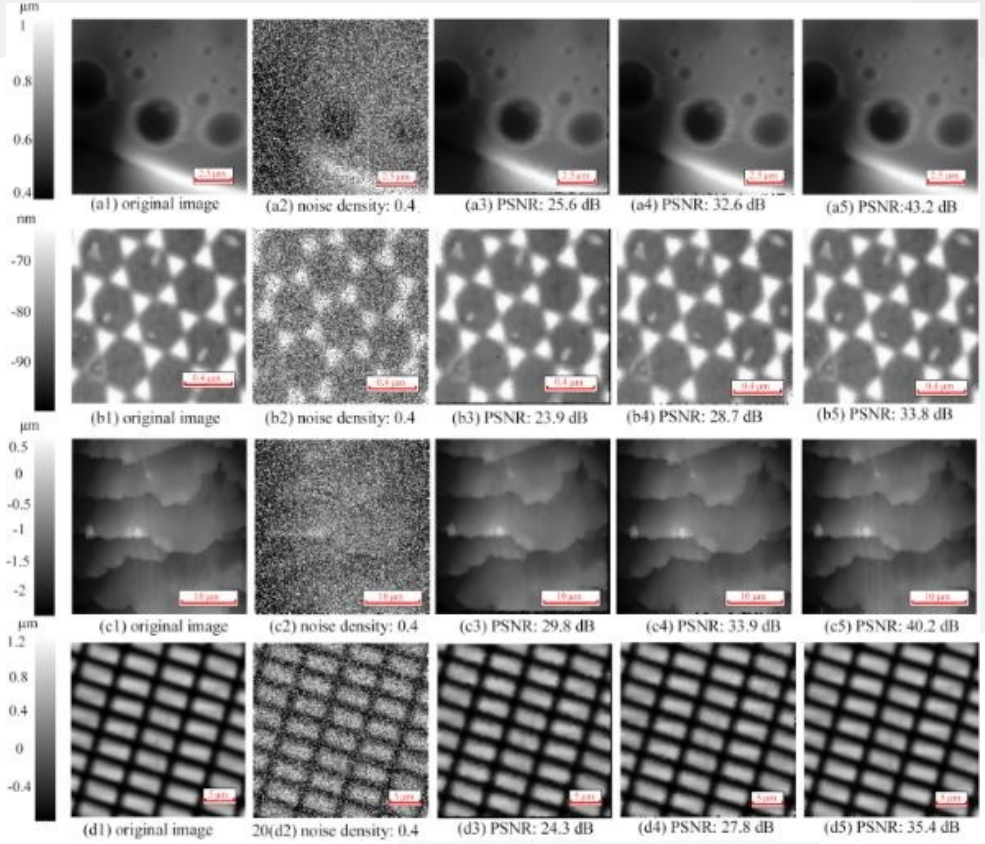
Deconvolution image processing

Deconvolution filters – 50-100 images input (**HS-AFM**):



Heath, G.R., Kots, E., Robertson, J.L. *et al. Nature* **594**, 385–390 (2021).

Denoising with AI:

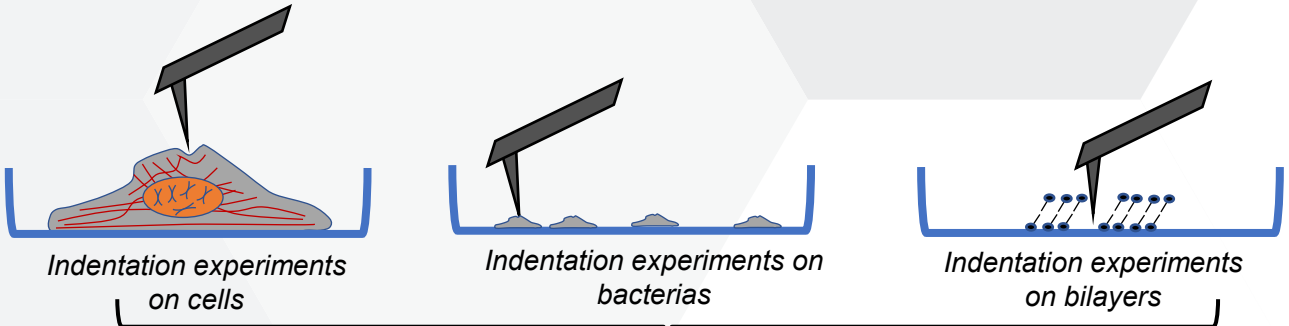


Beilstein J. Nanotechnol. **2019**, *10*, 2346–2356.

Advanced data processing

Mechanobiological data processing

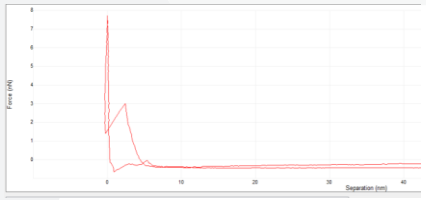
Indentation data processing

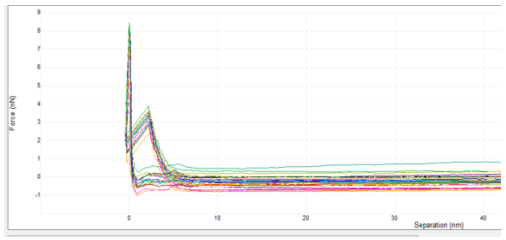


Indentation experiments on cells

Indentation experiments on bacterias

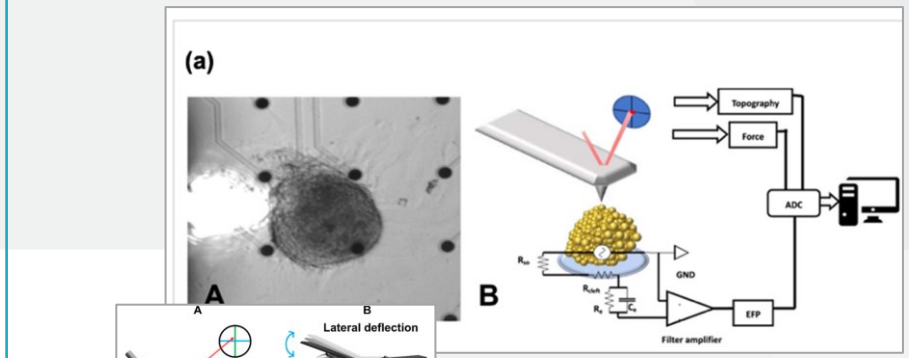
Indentation experiments on bilayers

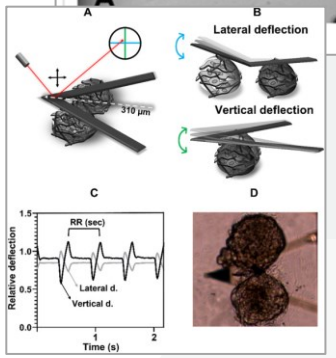




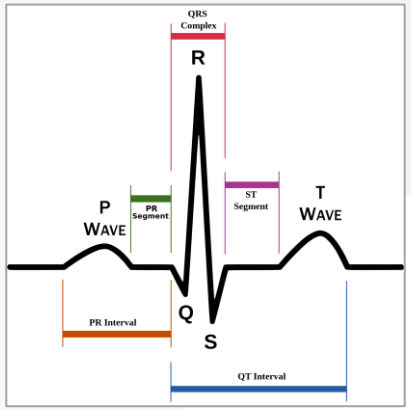
Data processing

Deep Data Correlation (Machine learning, ...)





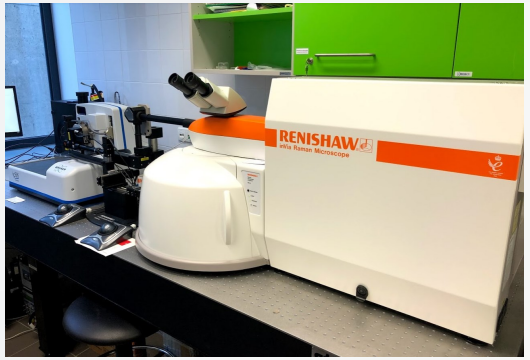
Mechanobiological+ electrophysiological data – **cell models**

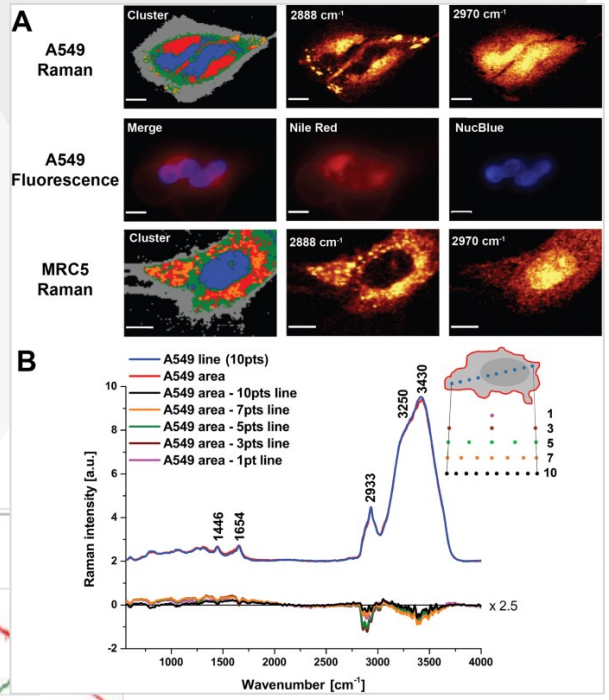


ECG – **patient's data**

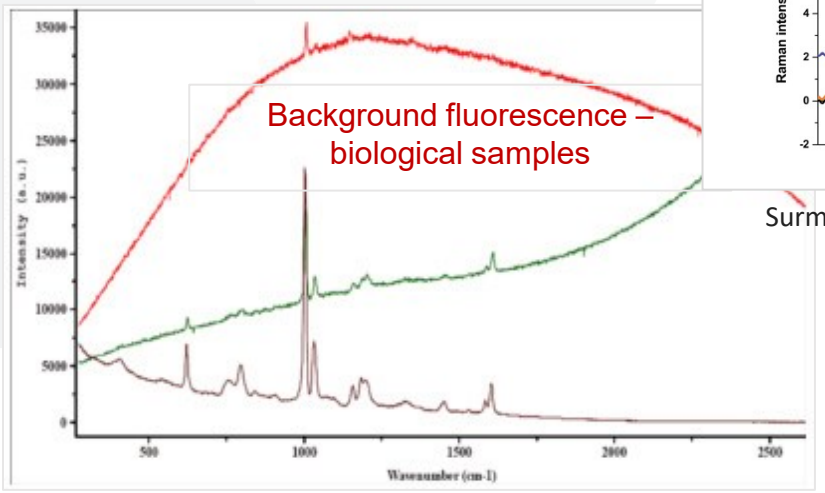
AI/ML – data correlation

2. Raman microscope upgrade
Renishaw InVia Raman microscope

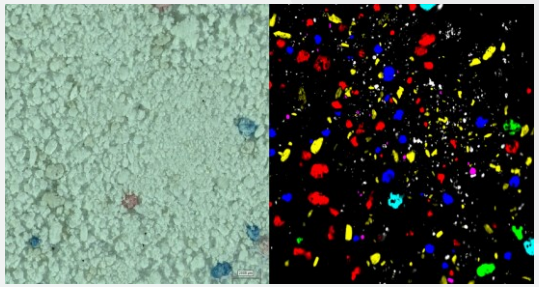




Surmacki, J.M., et al. *Sci Rep* **8**, 12604 (2018).



https://www.azom.com/article.aspx?ArticleID=2950



White light and Raman images of powder

Raman part - upgrade

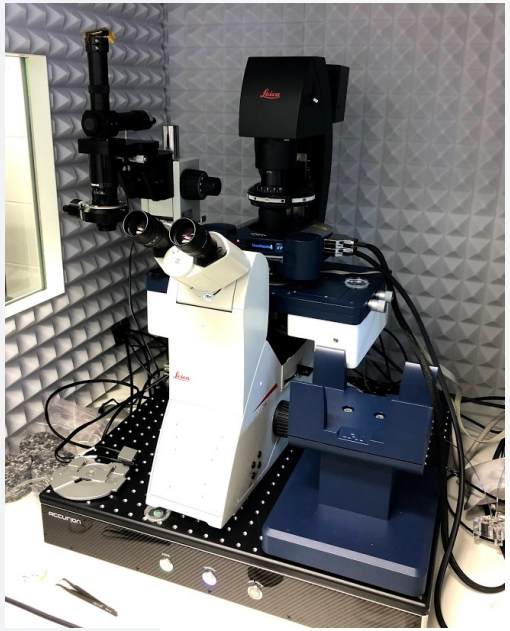
+ **laser 785 nm**, 100 mW (fluorescence decrease)
+ 1 x 785 nm **polarization**
+ 1 x 633 nm polarization
+ Software upgrade to version **WiRE 5.6**
(incl. **particle analysis** and spectral database modules – **microplastics**)

Full integration with AFM

- AFM correlative software
- AFM microscope antivibration solution

Price 140 tEUR

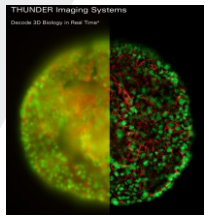
3. Leica Microscope Upgrade



Leica DMi8

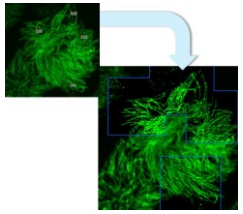
*(combined **with JPK NW4XP**)*

+



Leica THUNDER Imaging Systems

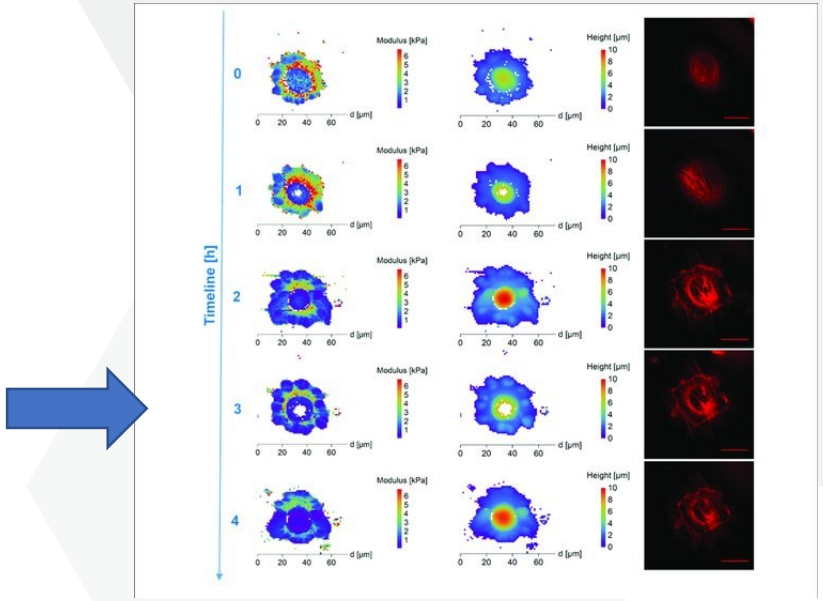
Easily tackle biologically relevant 3D models with THUNDER Imagers.
They bring you high-speed, multicolor imaging of thin and thick samples with increased temporal resolution in the first attempt itself.



Telight LiveCodim

From conventional to super-resolution microscopy

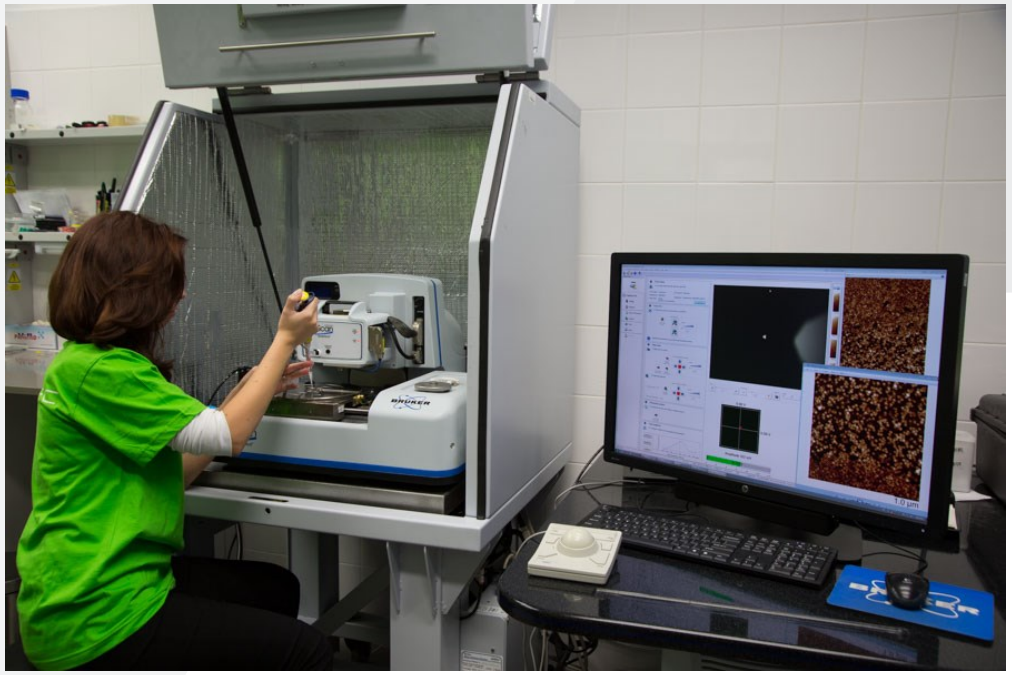
LiveCodim is a universal, super-resolution imaging platform, designed to interface with any standard fluorescence microscope. It is the solution for live imaging with high resolution and low phototoxicity.



AFM – confocal correlation microscopy

Price 120 tEUR

4. Bruker Dimension FastScan Upgrade



In everyday operation from 2014

AFM controller upgrade:

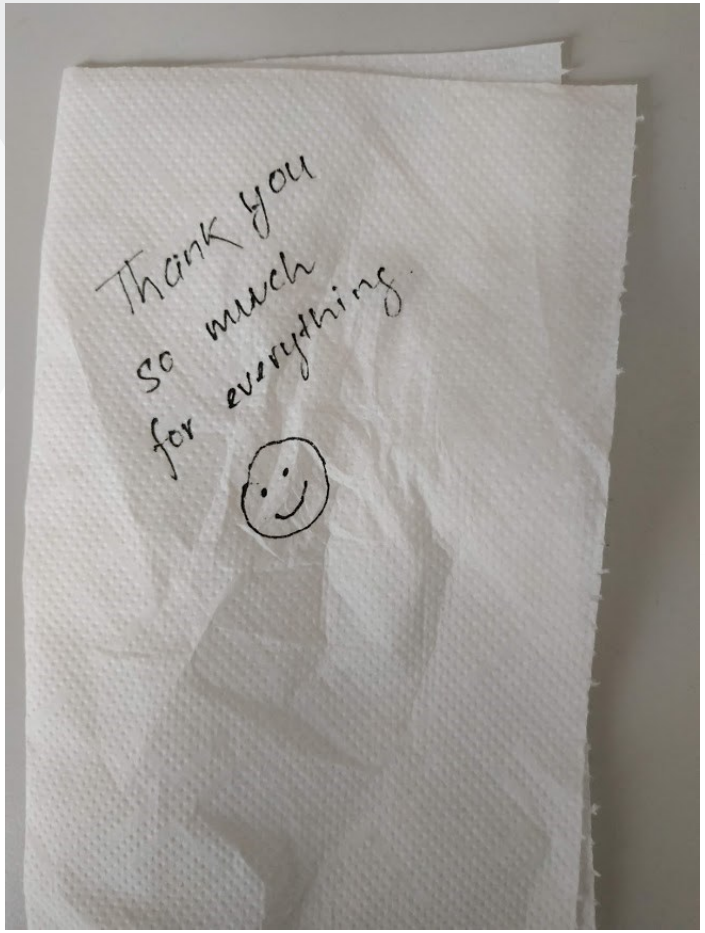
ATOMIC FORCE MICROSCOPY

NanoScope 6 Controller

Unmatched power and capabilities for Dimension Icon®, FastScan®, XR, HPI, Pro, and MultiMode® 8HR AFMs

Price 80 tEUR

Let's all the measurements end up with this...



Acknowledgment text - CIISB

- Preferred version: „CIISB, Instruct-CZ Centre of Instruct-ERIC EU consortium, funded by MEYS CR infrastructure project **LM2023042** and European Regional Development Fund-Project „UP CIISB“ (No. CZ.02.1.01/0.0/0.0/18_046/0015974), is gratefully acknowledged for the financial support of the measurements at the CF Nanobiotechnology.“

- Short version: „We acknowledge CF Nanobiotechnology of CIISB, Instruct-CZ Centre, supported by MEYS CR (**LM2023042**) and European Regional Development Fund-Project „UP CIISB“ (No. CZ.02.1.01/0.0/0.0/18_046/0015974).“

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Thank you for your attention.

Web: ceitec.eu/nanobio

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Czech Infrastructure for Integrative Structural Biology

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European Structural and Investment Funds
Operational Programme Research, Development and Education

MINISTRY OF EDUCATION, YOUTH AND SPORTS

OP VVV CZ.02.1.01/0.0/0.0/18_046/0015974

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MŠMT

Cytoplasmic live-cell biopsies for the temporal profiling of single-cells

Go beyond in single cell manipulation

Gentle and accurate single-cell injection and cytoplasmic biopsies

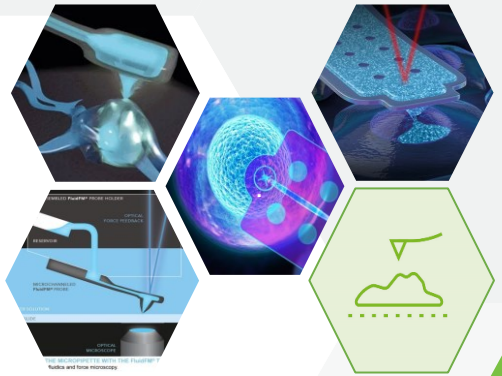
Fluidic force microscopy, or **FluidFM** is a biophysical technique for conducting **single-cell biopsies**. This innovative approach enables the extraction of a part of the cytoplasm from individual living cells while preserving their viability.

These cytoplasmic biopsies can be used for subsequent highly-sensitive, low-input **RNA-seq analysis** to characterize **single cells multiple times** throughout their lifetime.

Moreover, the **FluidFM Nanosyringes** extend their utility by facilitating the **targeted introduction** of various molecular components into cells, including **RNA**, **DNA**, proteins, and even molecular complexes such as **CRISPR/Cas9 RNPs**.

This functionality streamlines the transfection processes for plasmids and transcription factors and enables entire cell line engineering workflows.

By exploring the capabilities of **FluidFM** in this seminar, we seek to uncover its **potential implications** for advancing the comprehension of intricate cellular processes, thus fostering new dimensions in **cellular analysis** and **molecular investigation.**



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October 18th 2023

University Campus Bohunice
Brno, Czech Republic
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