



INSTITUT ZA FIZIKU

# *NanoBio group*

equipment showcasing

Goran Zgrablić

3rd May 2023

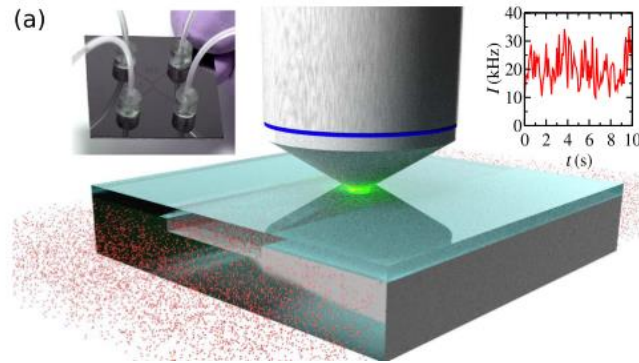
Institute of physics, Zagreb

# Fluorescence Correlation Spectroscopy (FCS) & Time Correlated Single Photon Counting (TCSPC)



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Goran Zgrablić, Tomislav Vuletić IF



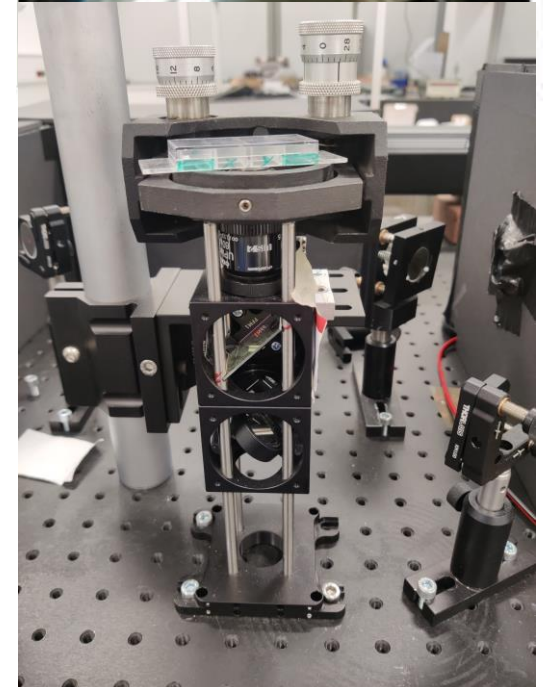
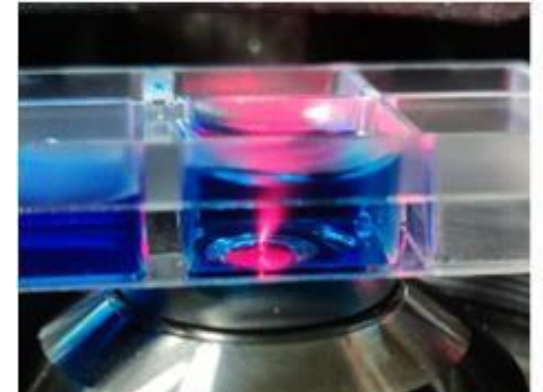
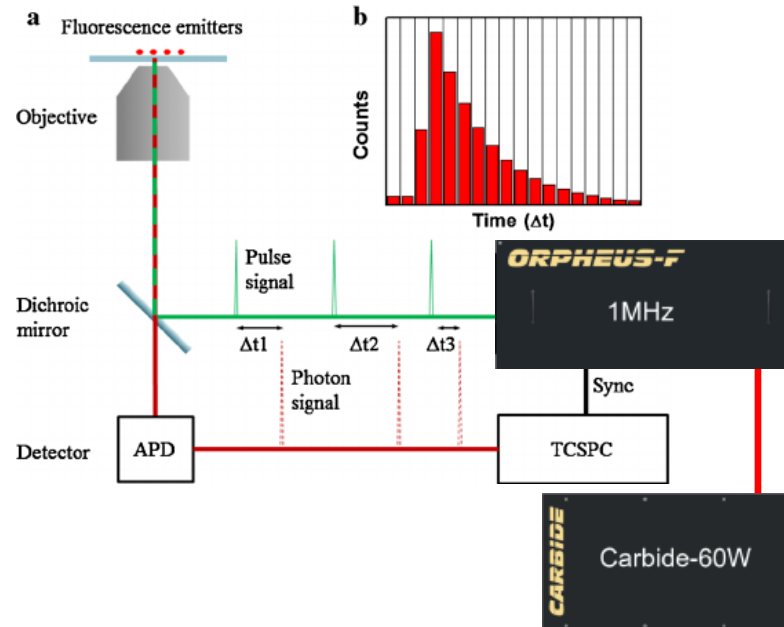
Simon Gravelle et al, J. Chem. Phys. 151, 244503

## CW EXCITATION

- excitation wavelength: **633 nm**
- dye concentration: **1-200 nM**
- spatial resolution: **XY 0.5  $\mu\text{m}$ , Z 1.5  $\mu\text{m}$**
- observation volume: **1.8 fL**
- diffusion time constant: **1 - 10000  $\mu\text{s}$**

## PICOSECOND PULSE EXCITATION

- repetition rate: **1 MHz**
- pulse duration: **1-2 ps**
- excitation wavelength:  
OPA: **640 - 950 nm**  
SHG: **320 - 475 nm**
- time resolved photoluminescence  
with **time resolution of 20 ns**

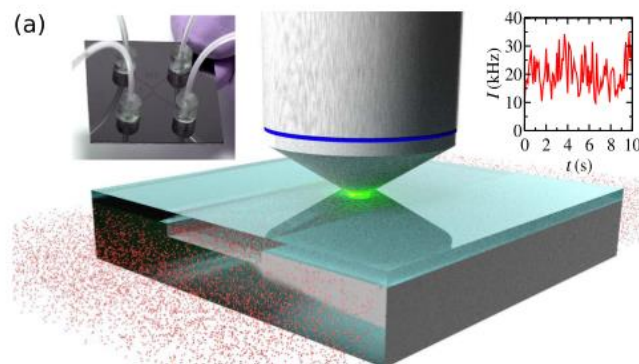


# Fluorescence Correlation Spectroscopy (FCS) & Time Correlated Single Photon Counting (TCSPC)

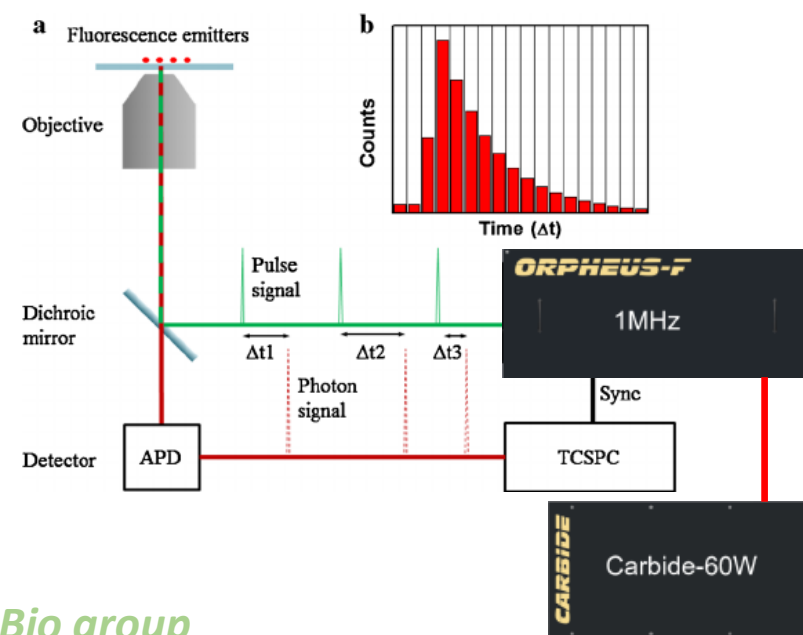


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## MATERIAL SCIENCE

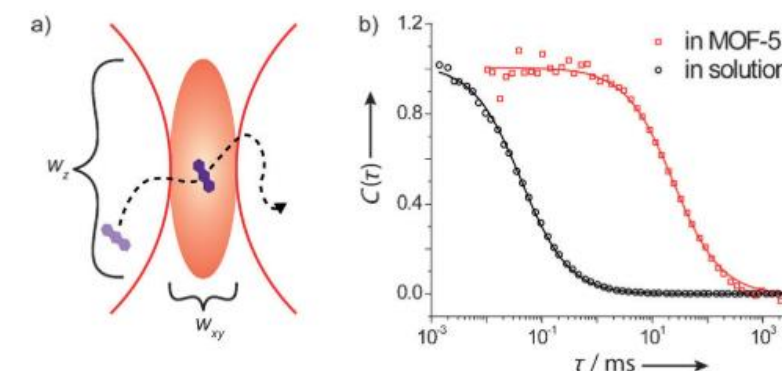
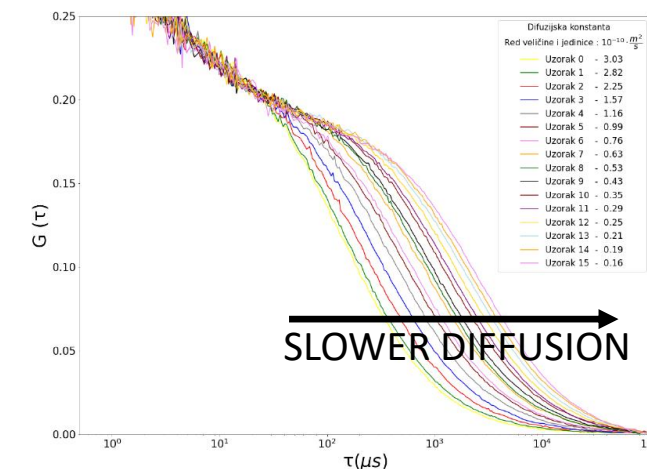
- tracking nanoparticles – transport properties
- polymers – its diffusion properties and dynamics in various materials

## SURFACE SCIENCE

- adsorption and desorption dynamics of molecules on surfaces
- surface diffusion
- binding interactions on functionalized surfaces

## (PHOTO)CATALYSIS

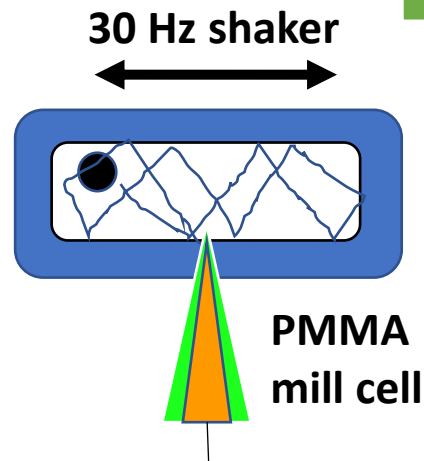
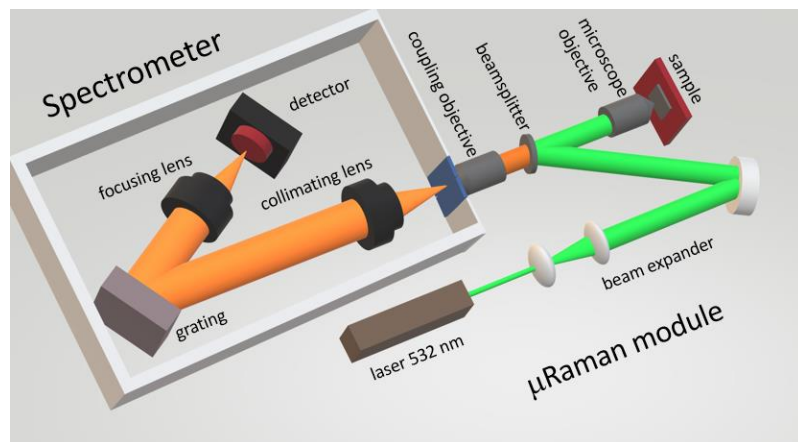
- diffusion of reactants and products in catalytic systems
- catalyst characterization: size, activity, and stability, by studying the behavior of fluorescent probes on or near the catalyst surface



Angew. Chem. Int. Ed. 2012, 51, 2662 –2666

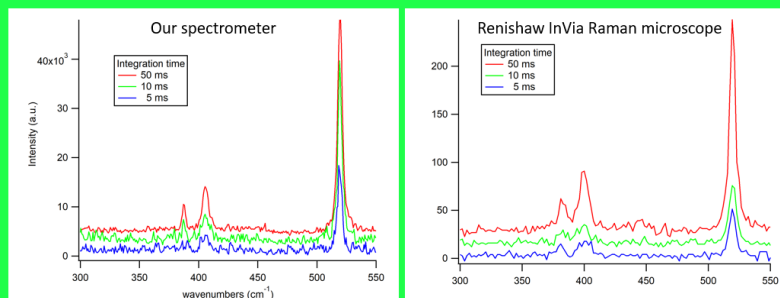
# Confocal $\mu$ -Raman spectrometer for mechanochemistry

Davor Čapeta, Mario Rakić, Goran Zgrablić, IF  
Krunoslav Užarević, Group for green chemistry, IRB



to spectrometer

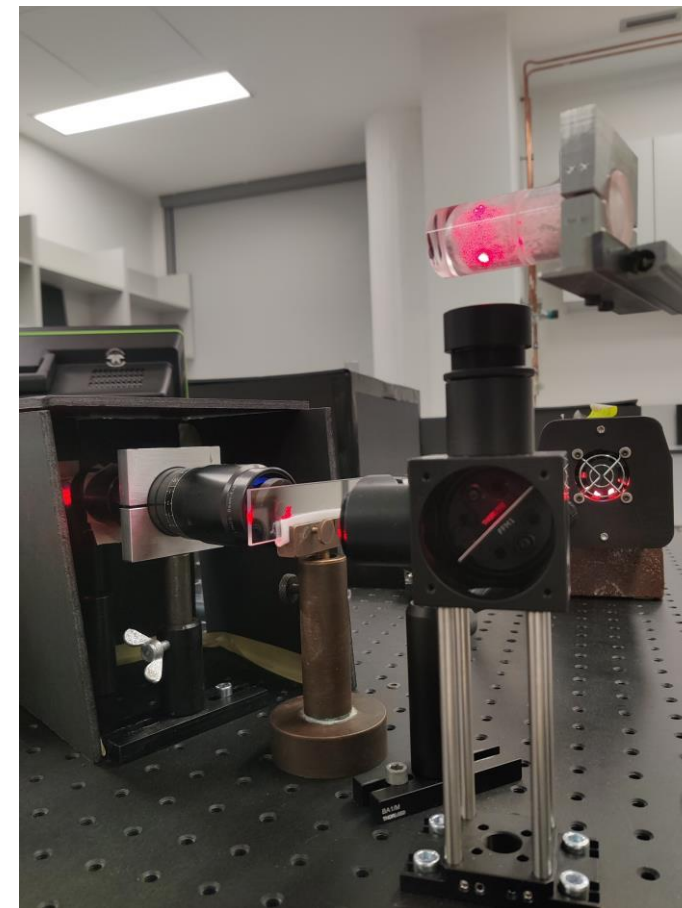
Throughput comparison with research-grade confocal Raman microscope



Experimental parameters for both devices:  
- Sample: monolayer of MoS<sub>2</sub> on Si substrate  
- Excitation power: 1.3 mW

The Renishaw system was used with 1800 lin/mm grating and 250 mm focusing lens, thus spectral resolution is slightly lower.

- real-time monitoring of chemical reactions
- cost without laser: **2500 €**
- comparable throughput to Renishaw
- spectral/spatial resolution: **8-6 cm<sup>-1</sup> / 5  $\mu$ m**
- excitation wavelength: **633 nm**
- spectral coverage: **200 - 3500 cm<sup>-1</sup>**
- time resolution: **< 500 ms**



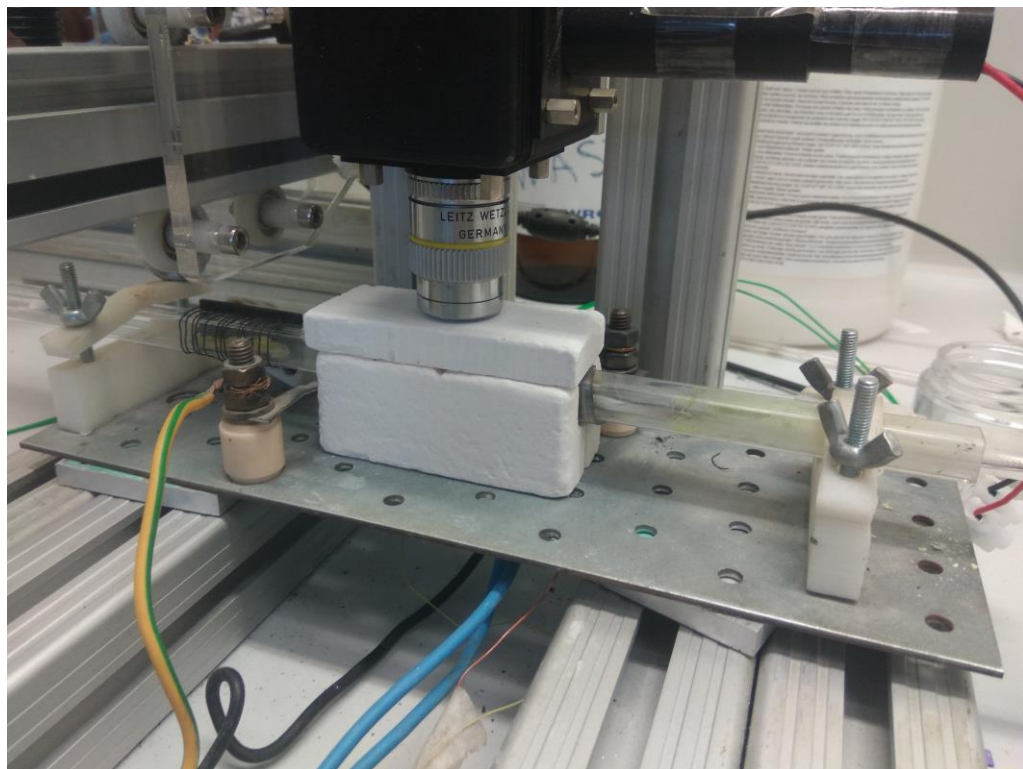


# Oven for synthesis of 2D materials



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- experience with growing of:  
 $\text{MoS}_2$ ,  $\text{WS}_2$ ,  $\text{NbS}_2$ ,  $\text{SnS}_2$ , graphene and heterostructures



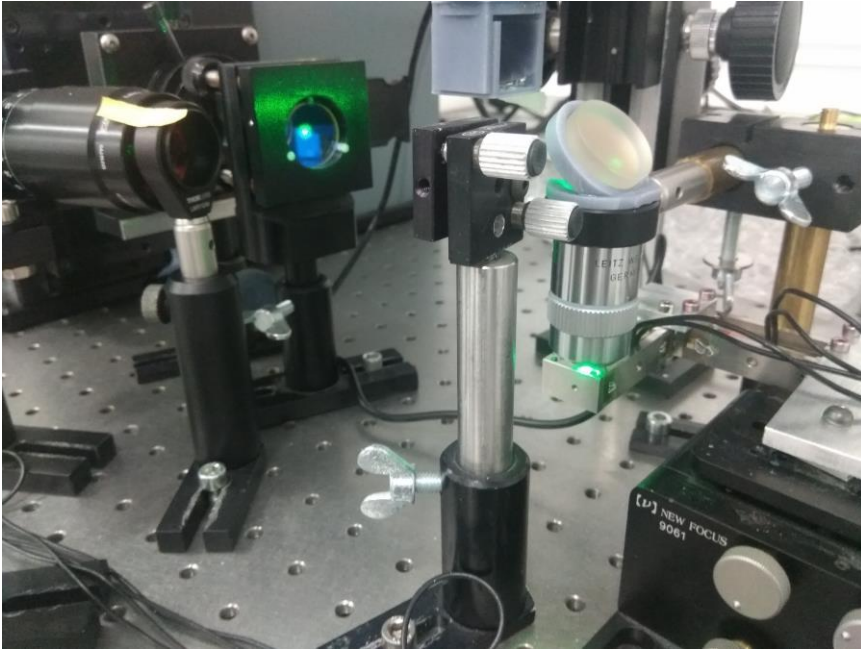
*$\text{MoS}_2$  triangles on the  $\text{Si}/\text{SiO}_2$  substrate*

# Confocal microscope for Raman and PL mapping



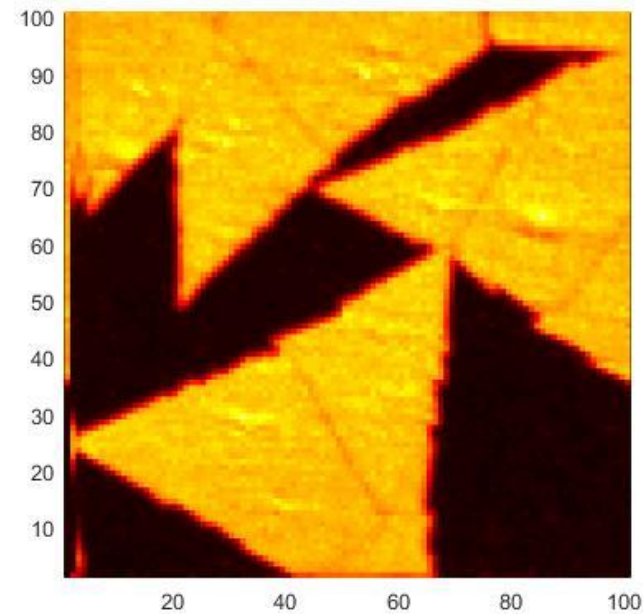
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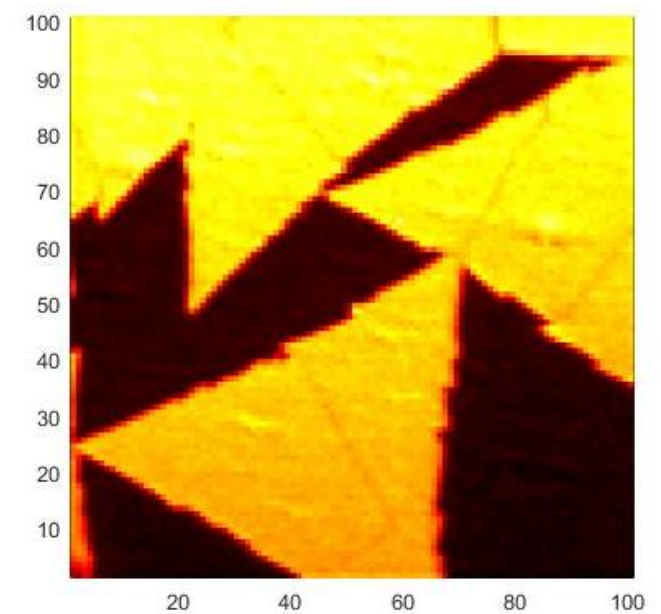


- excitation wavelength: **532 nm**
- spectral/spatial resolution:  
**4 - 2.5 cm<sup>-1</sup> / 1 μm**
- MoS<sub>2</sub> maps:  
**range 30x30 μm, step 300 nm**

PHOTOLUMINESCENCE MAP



RAMAN MAP

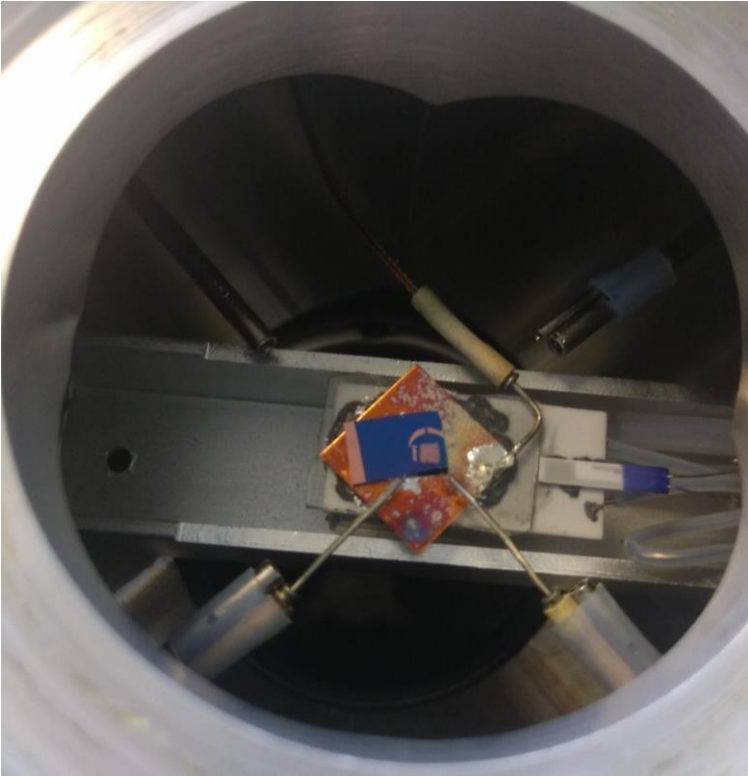


# Probe station & IV characterization

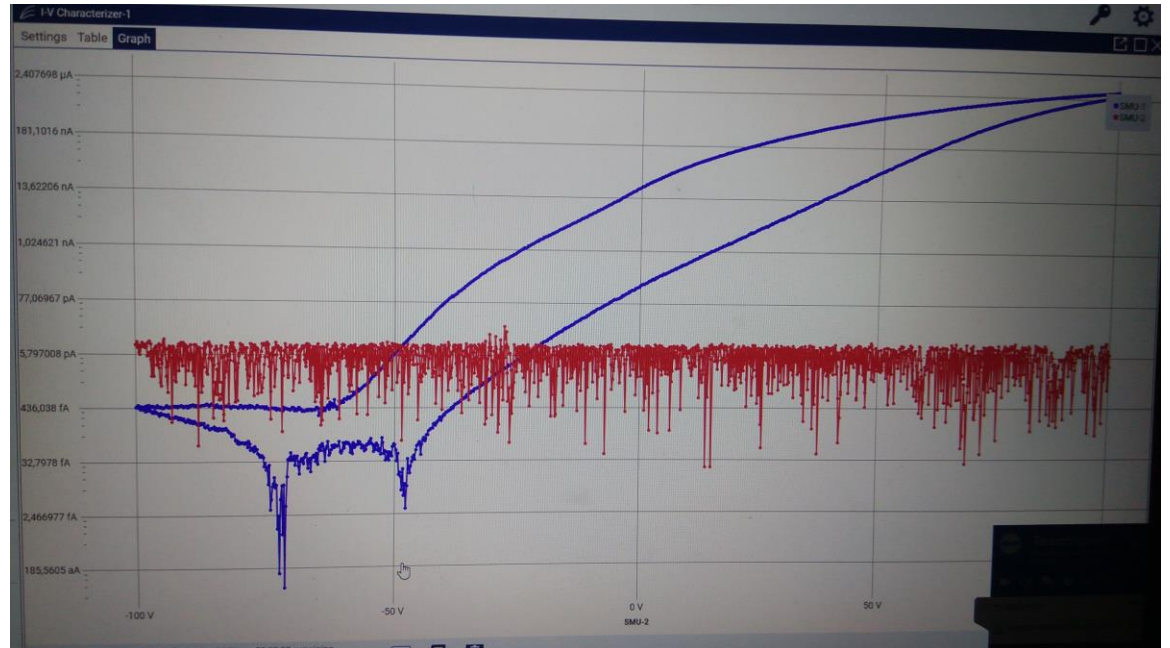


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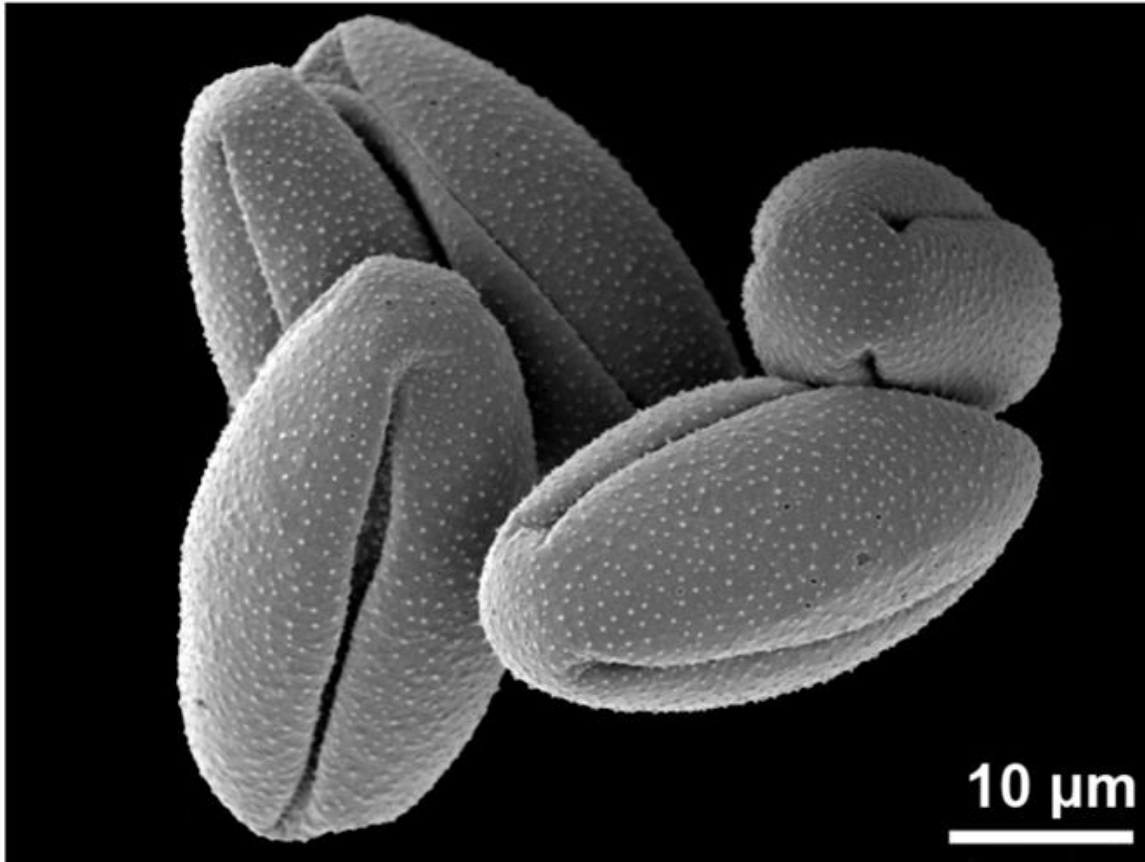


- pressure:  **$<10^{-5}$  mbar**
- noise:  **$<1$  pA** (up to 10 fA)
- displacement of probes:  **$<50$   $\mu\text{m}$**



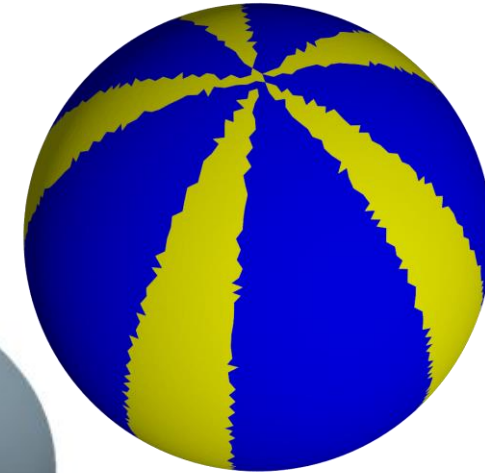
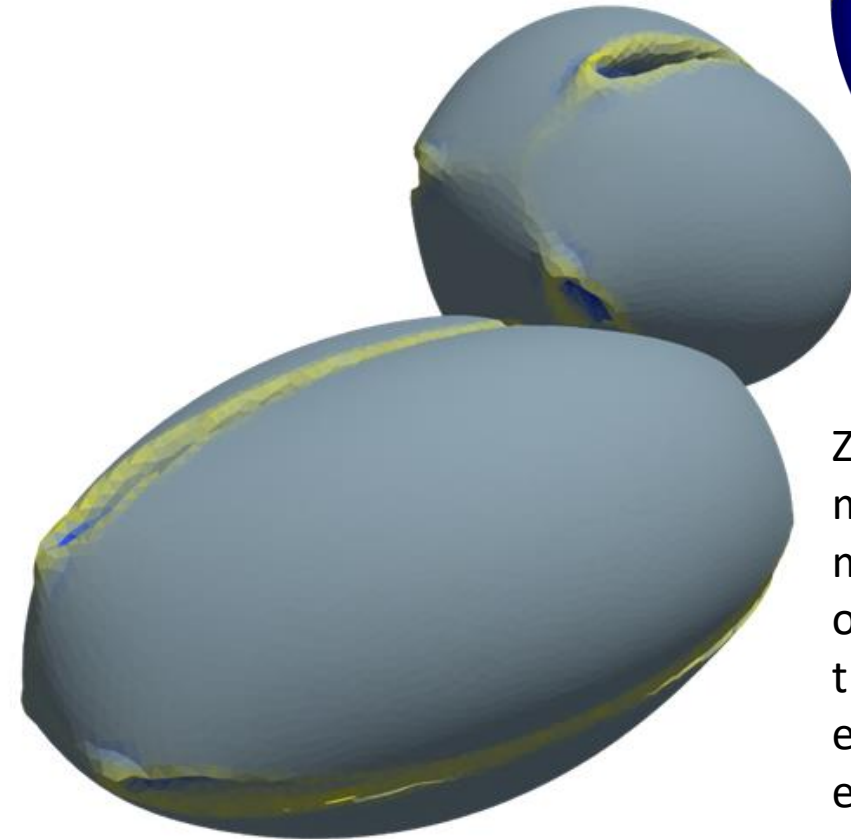
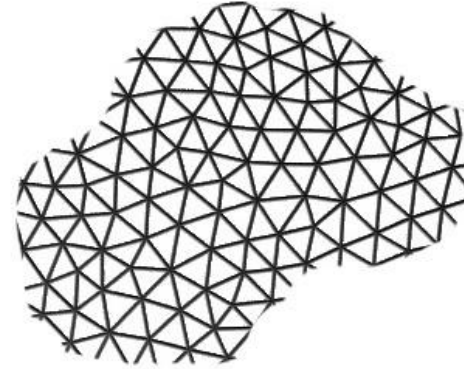


Mehanički hamiltonijani na mrežama; elastične nehomogenosti, kompleksni oblici u nenapregnutom stanju



*Globularia vulgaris* (PalDat)

Kolaps pod vanjskim tlakom, eksplozije i plastične deformacije pod unutarnjim tlakom



Zrna peludi, mikrokapsule, dizajn mehaničkog odgovora ljusaka na tlak, mehanika i evolucija oblika i elastičnih nehomogenosti

Antonio Šiber, IF