THE nanoparticles SCOPE: DEVELOPMENT OF A NEW INTEGRATED INSTRUMENT FOR ACCURATE AND REPRODUCIBLE PHYSICO-CHEMICAL CHARACTERISATION OF NANOPARTICLES

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THE npSCOPE PROJECT IN A NUTSHELL

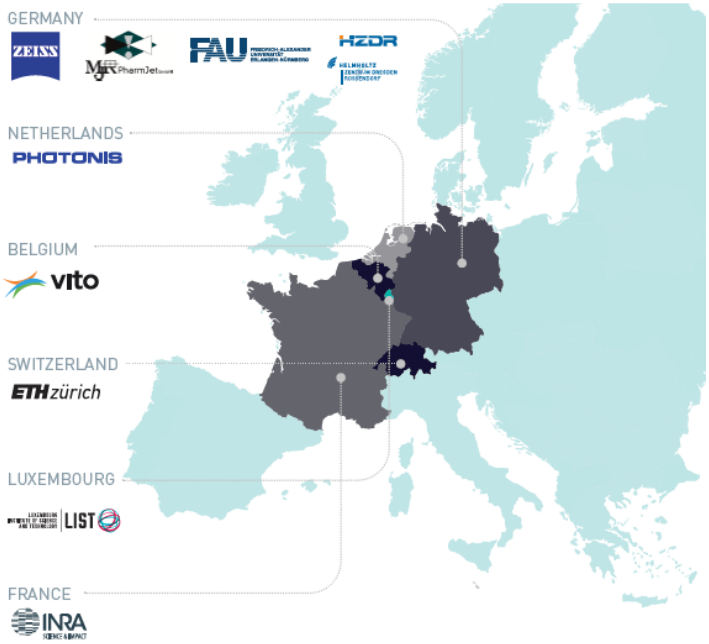
It answer the call NMBP-26-2016/2017

“Analytical techniques and tools in support of nanomaterial risk assessment.”

9 partners

Total European Contribution
About 6.5 kk€

Coordinator
Luxembourg Institute of Science and Technology



OBJECTIVE OF THE npSCOPE PROJECT

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The main objective of the npSCOPE project is to **Built**, **Test** and **Qualify** an innovative analytical platform that combines:

- Helium Ion Microscopy
- Secondary Ion Mass Spectrometry
- Secondary Transmitted Ion Spectrometry
- All of the above techniques under Cryo-Stage

This will allow, with only one analytical platform to

- Fully characterise individual nanoparticles
- and their interaction with their environment (tissue, cells, etc)
- to better understand the risks they might pose to human health or the environment

OBJECTIVE OF THE NPSCOPE PROJECT

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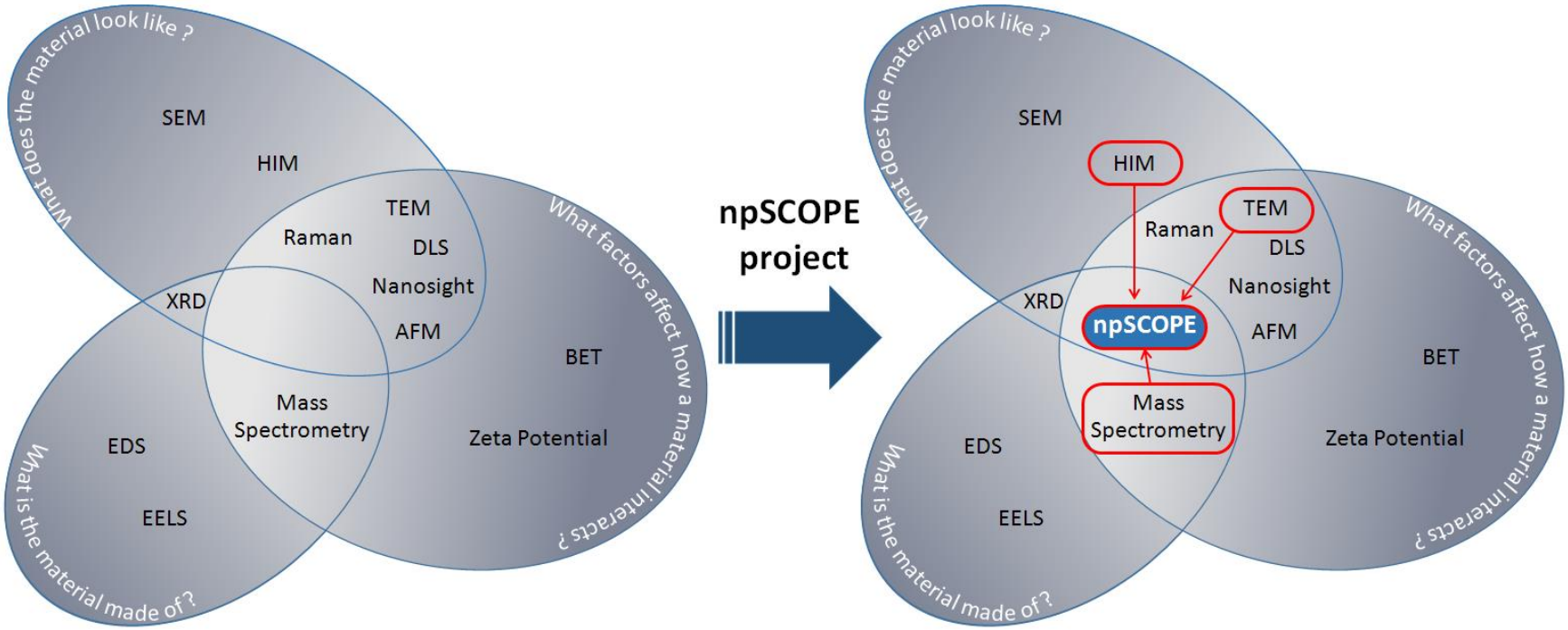
⇒ The npSCOPE platform will allow answering these main questions:

- What does the material look like?
- What is the material made of?
- What factors affect how a material interacts with its surroundings?



OBJECTIVE OF THE npSCOPE PROJECT

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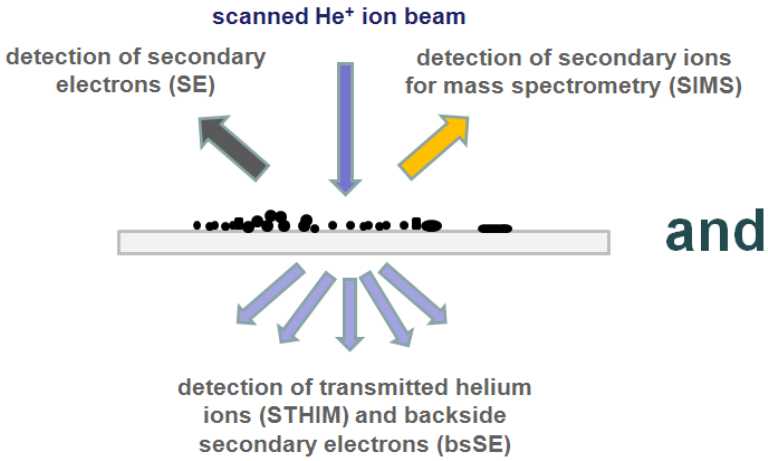
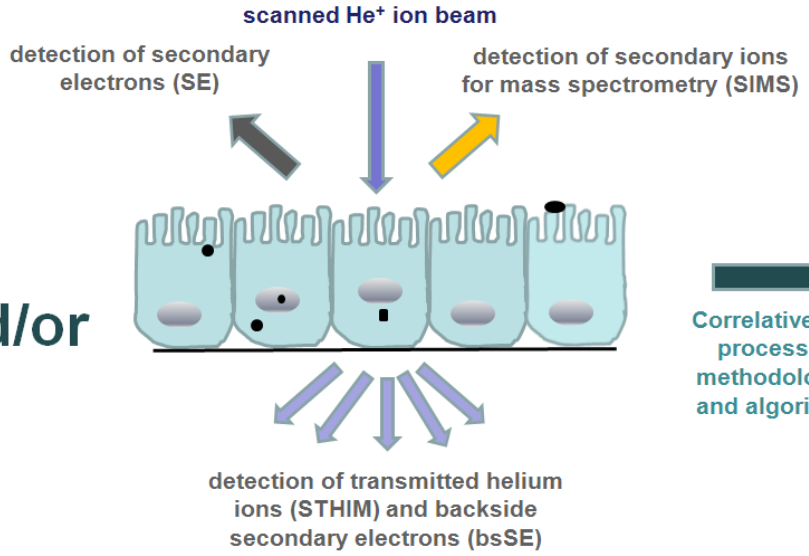
npSCOPE on raw nanoparticles

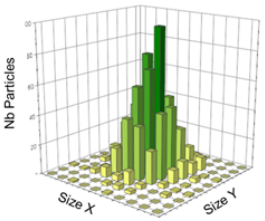


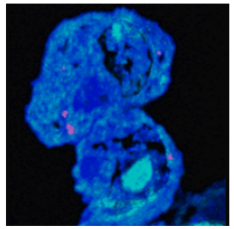
and/or

npSCOPE on nanoparticles in complex matrices



Correlative data processing methodologies and algorithms





- Precise localisation of the nanoparticles at the sub-cellular level
- Interaction of the nanoparticles with the biological system
- Chemical composition of the nanoparticles
- Morphology of the nanoparticles
- Size distribution of the nanoparticles
- Density of the nanoparticles

INSTRUMENT DEVELOPMENT

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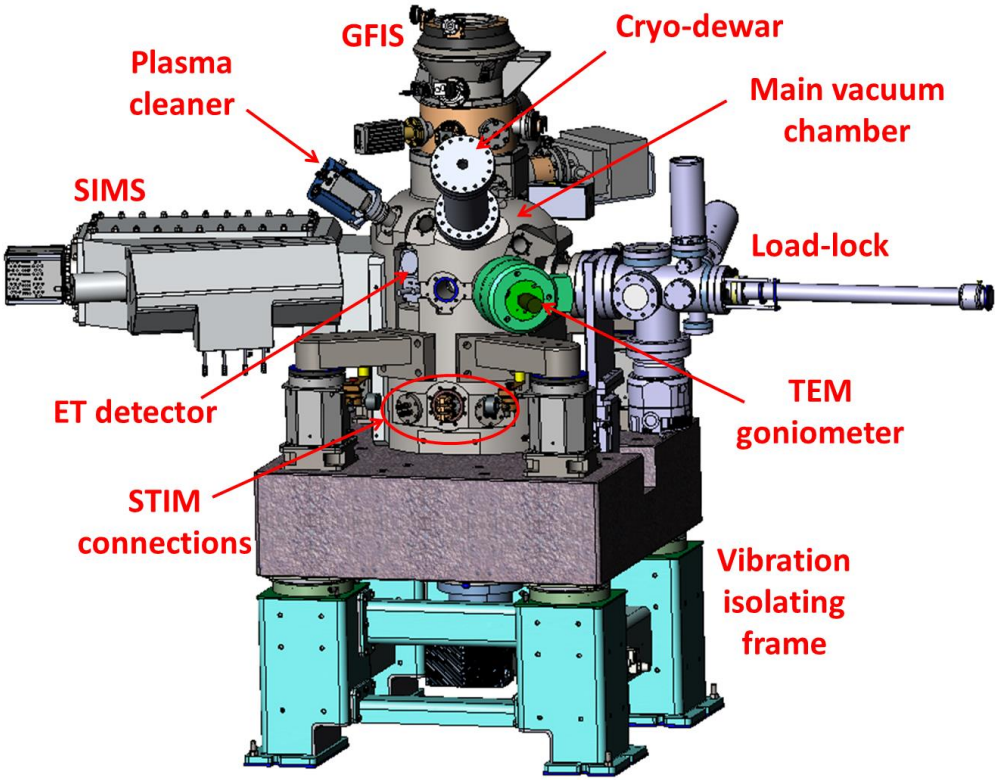
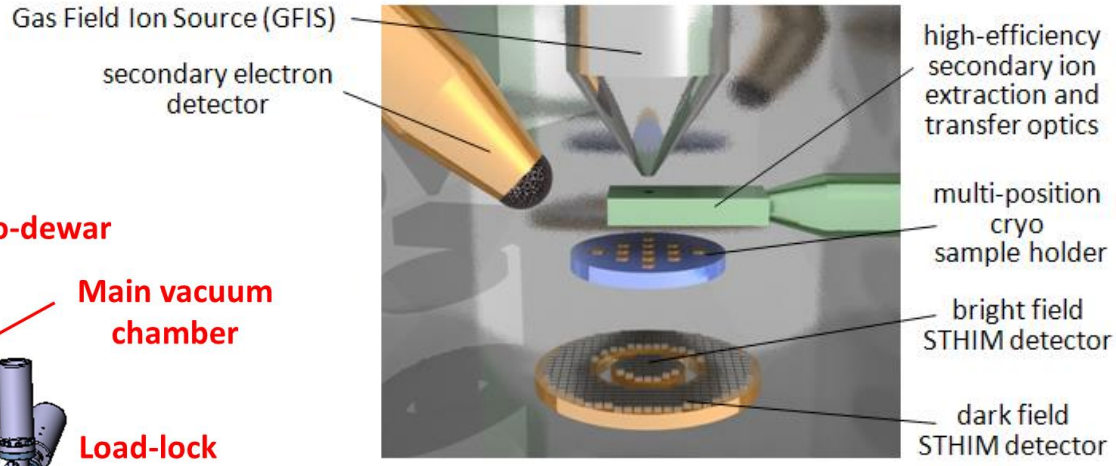
Instrument overview





Schematic of chamber interior

INSTRUMENT DEVELOPMENT

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Key performance specifications

Imaging resolution detecting secondary electrons	0.5 nm
Imaging resolution detecting secondary ions	4 nm (not mass filtered) 10 nm (mass filtered)
Imaging resolution detecting transmitted helium	0.5 nm
Mass resolution of the mass spectrometer	$M/\Delta M > 500$ if slits are fully open ($M/\Delta M$ will further increase when closing the slits)
Overall extraction and transmission efficiency of the mass spectrometer	40 %
Detection limits in the SIMS mode	10^{-3} (i. e. 0.1 at%) for nanoparticles having a volume of 100 nm^3, to ppm (i.e. 10^{-4} at%) for nanoparticles having a volume of 10^5 nm^3

INSTRUMENT DEVELOPMENT
GAS FIELD ION SOURCE (GFIS) (ZEISS)

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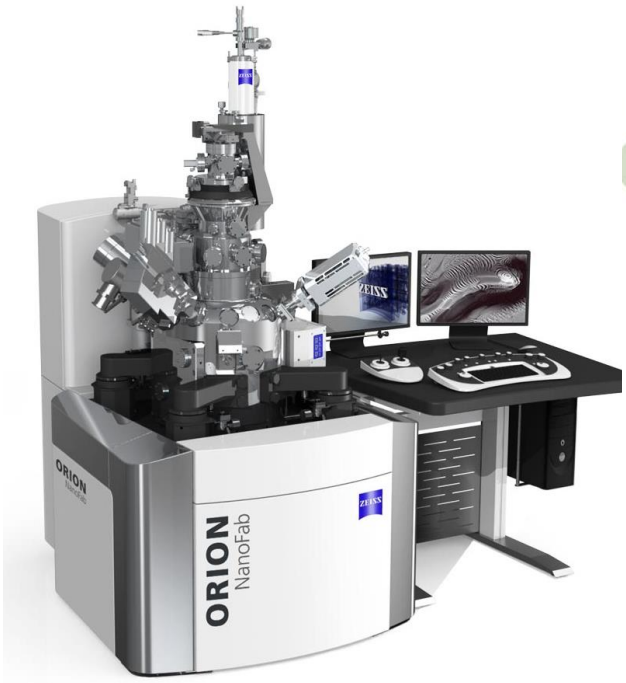
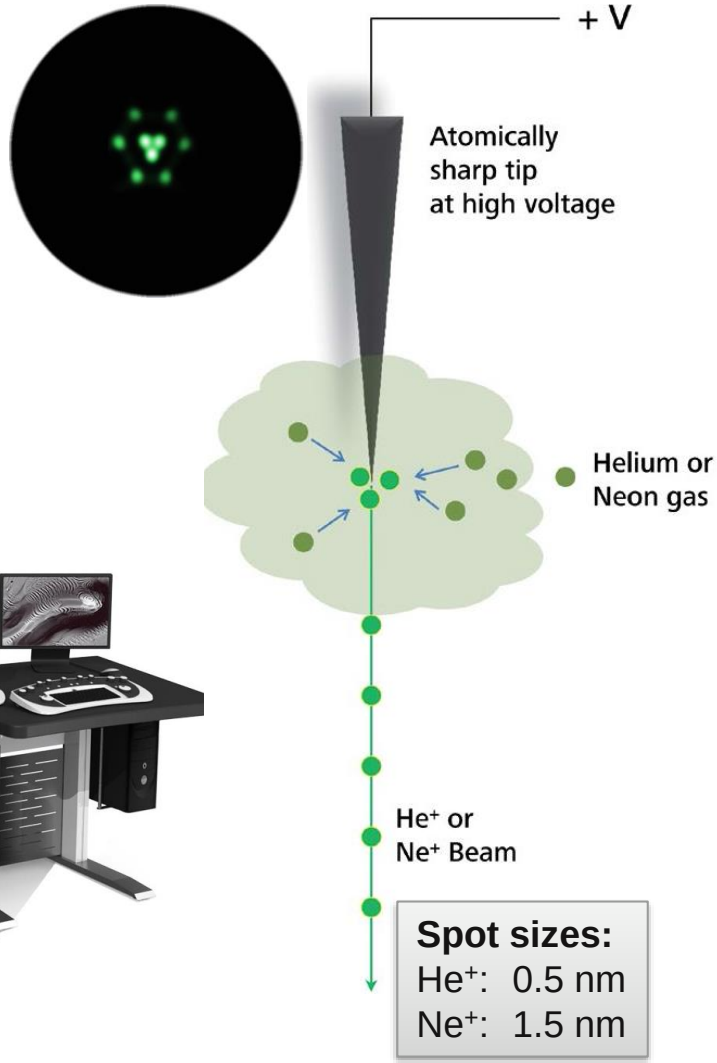
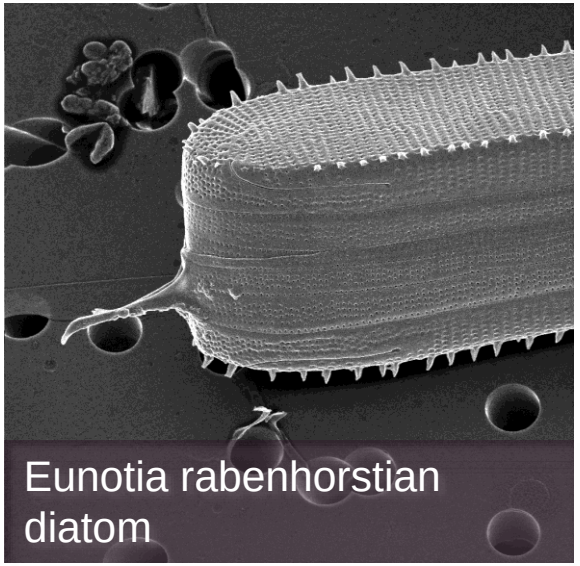





Pd catalyst grown on ZnO nanowires


Eunotia rabenhorstian diatom

INSTRUMENT DEVELOPMENT
MAIN VACUUM CHAMBER

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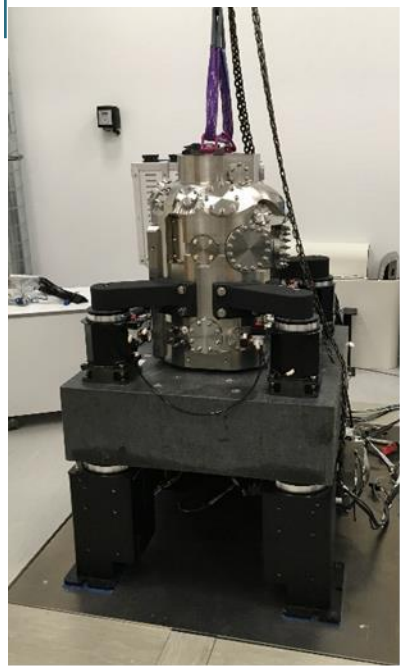
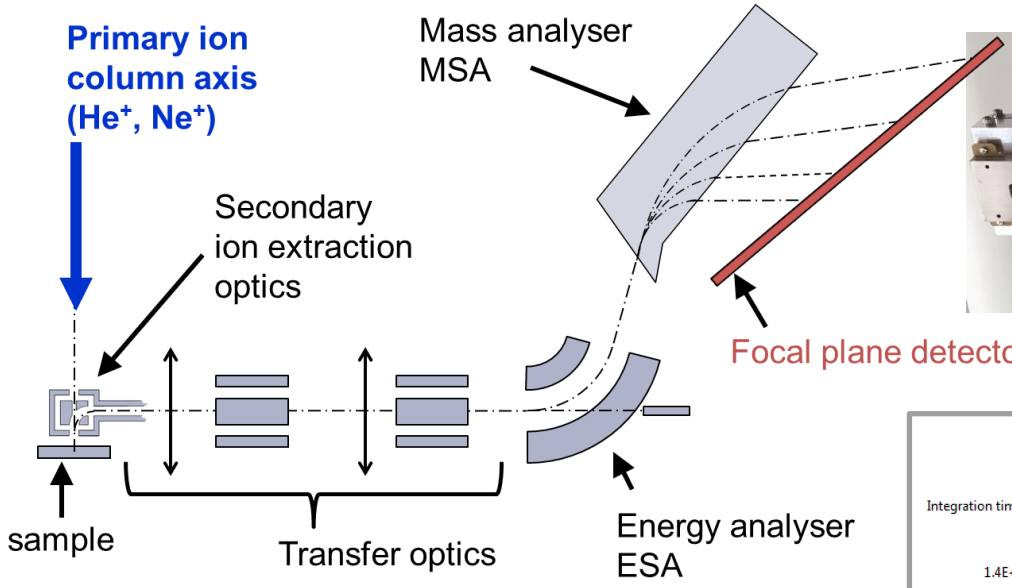
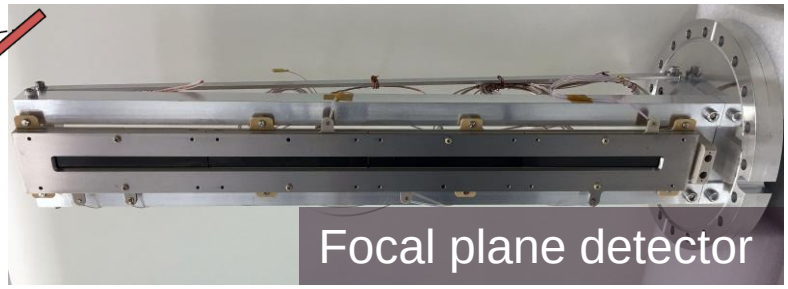


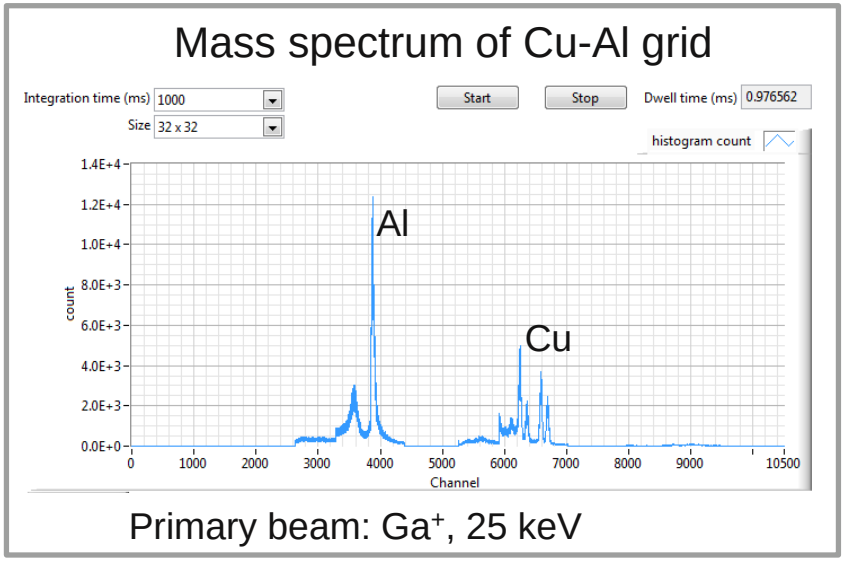
Mounting of:
- GFIS column
- ET detector
- Flood gun
- Standard Zeiss NanoFab sample stage and load-lock

Base pressure of around $5x10^{-8}$ mbar

INSTRUMENT DEVELOPMENT
SIMS SUB-SYSTEM







INSTRUMENT DEVELOPMENT
SIMS SUB-SYSTEM

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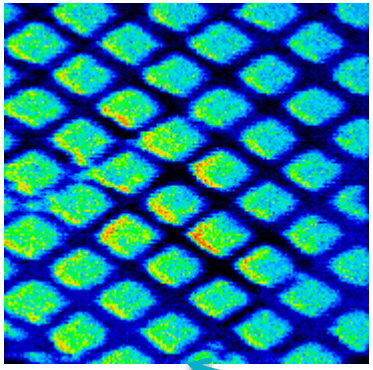
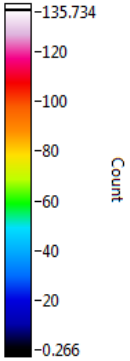
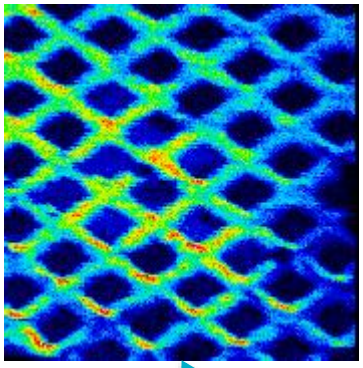
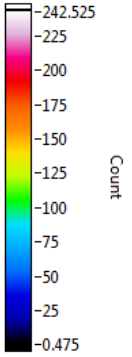
Al



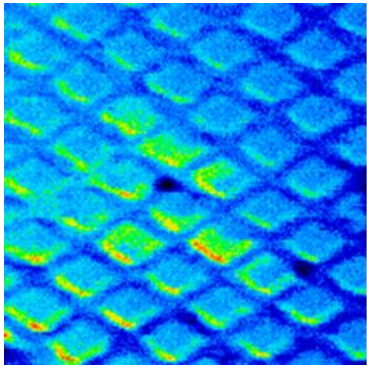


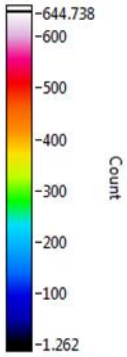
Cu

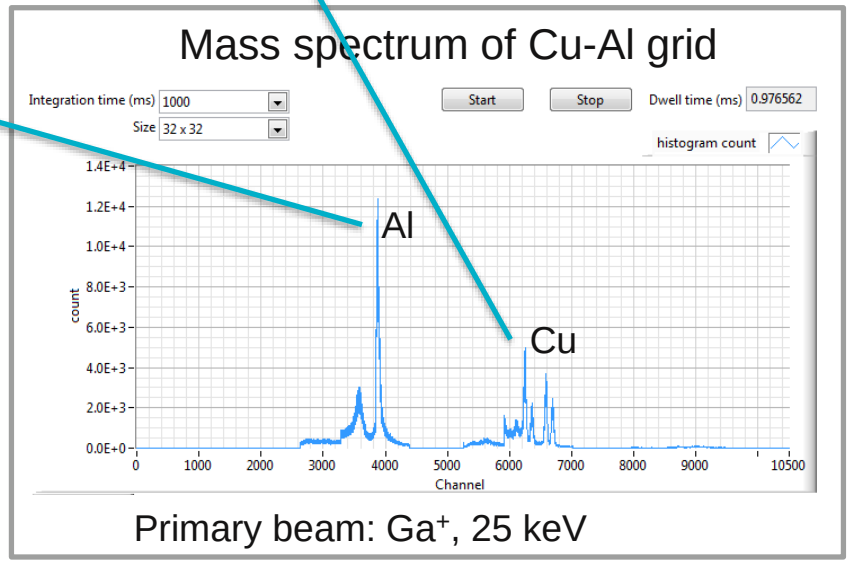




Total counts







INSTRUMENT DEVELOPMENT
CRYO SUB-SYSTEM

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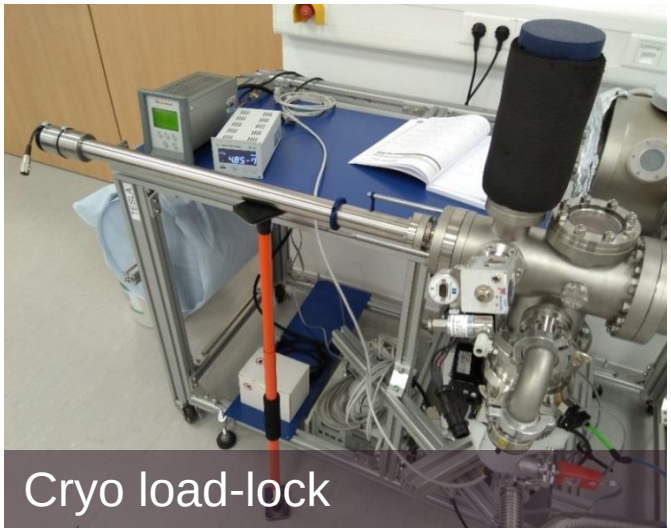
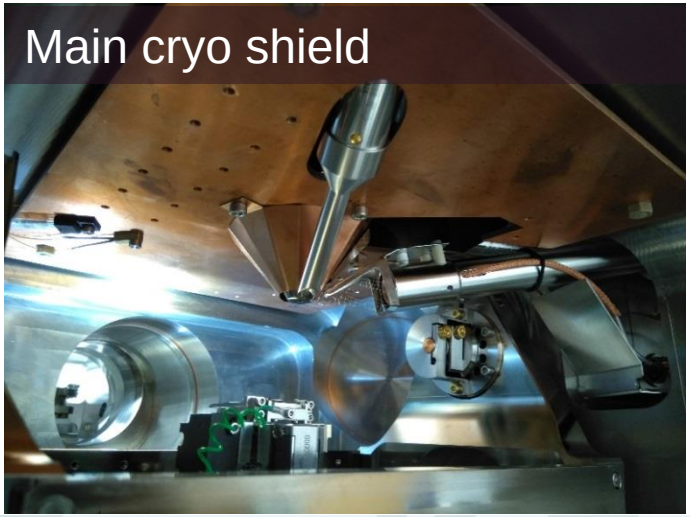
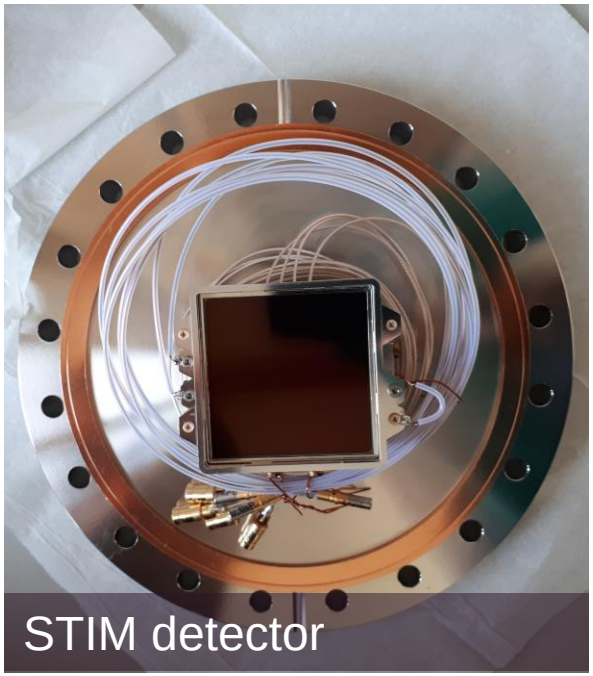

Cryo load-lock

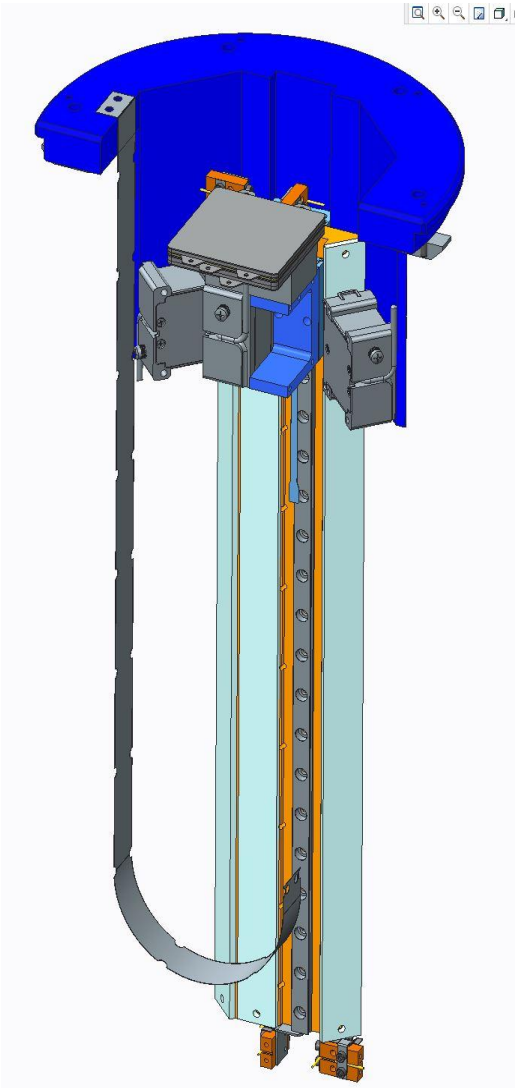

Dewar


Main cryo shield


Main cryo shield

INSTRUMENT DEVELOPMENT
STIM SUB-SYSTEM


STIM detector



TEST CASES FOR THE npSCOPE

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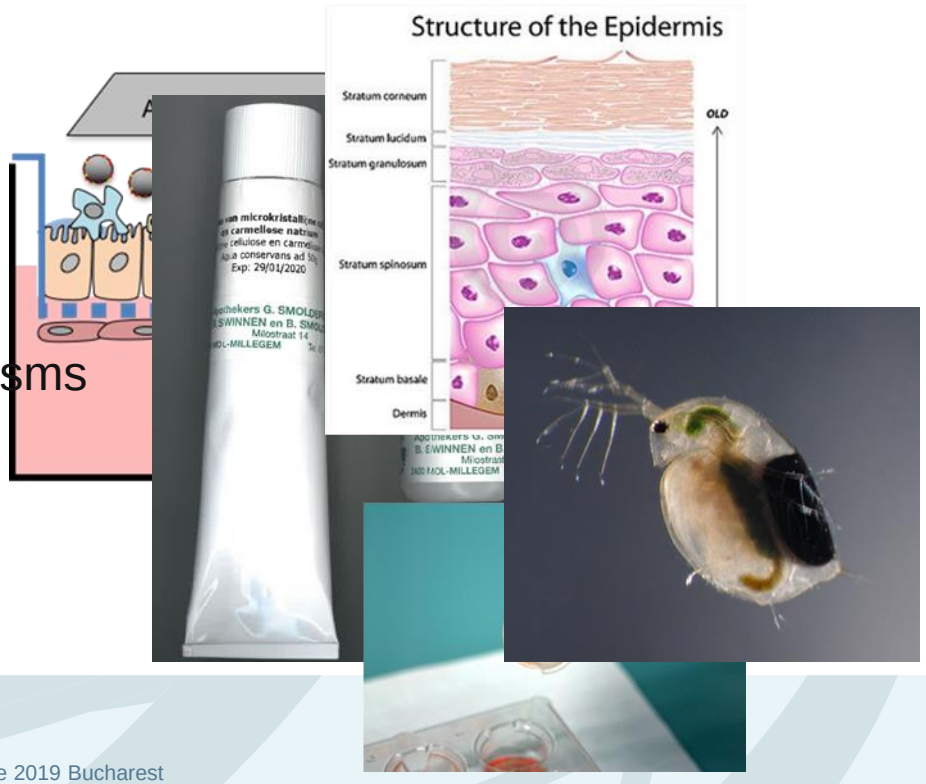
A number of tests cases will be prepared and analyzed with the npSCOPE platform, using different materials (shape, core material, shape, concentrations, etc.)

The test cases will be developed for testing and benchmarking purposes, but also to allow future npSCOPE users to reproduce samples (and hopefully the results) using well-established methods.

- Oral exposure & food products
- Respiratory exposure and aerosols
- Dermal exposure & cosmetic products
- Fresh water matrix & fresh water organisms
- Soil matrices & terrestrial organisms



APPLICATION

ANALYSIS OF FOOD-GRADE TiO_2 NPs IN E. COLI BACTERIA

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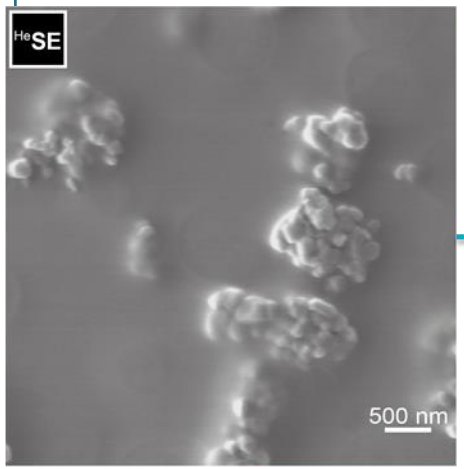
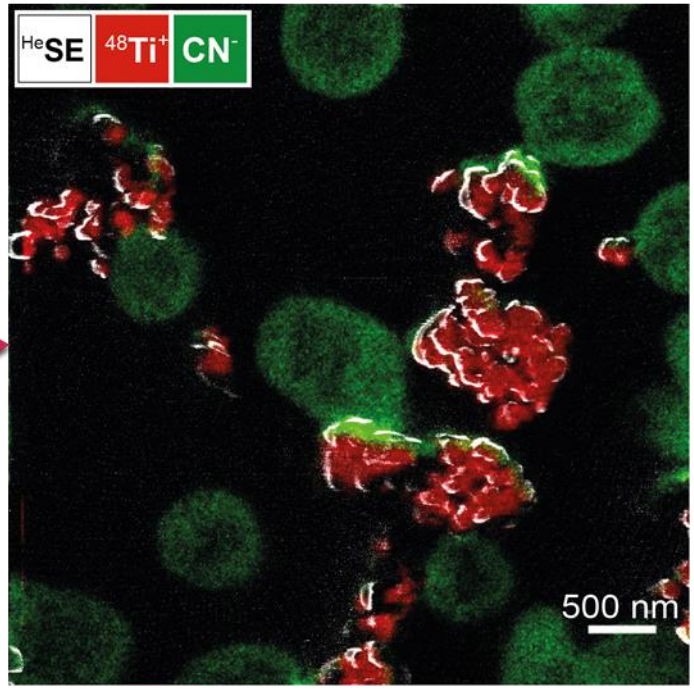
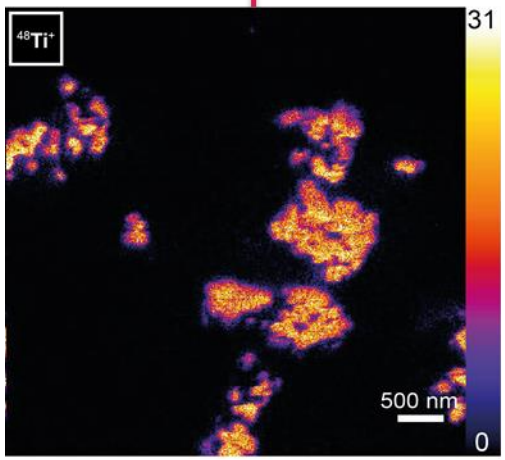
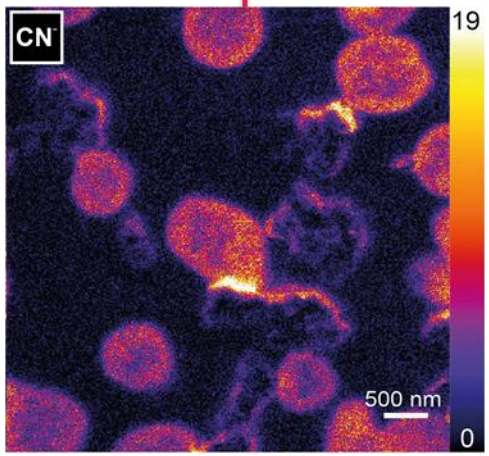


SE
20 keV He^+ / I_p=5.8 pA
2048 ×2048 pixels
20 µs/pixel
FoV 5×5 µm²

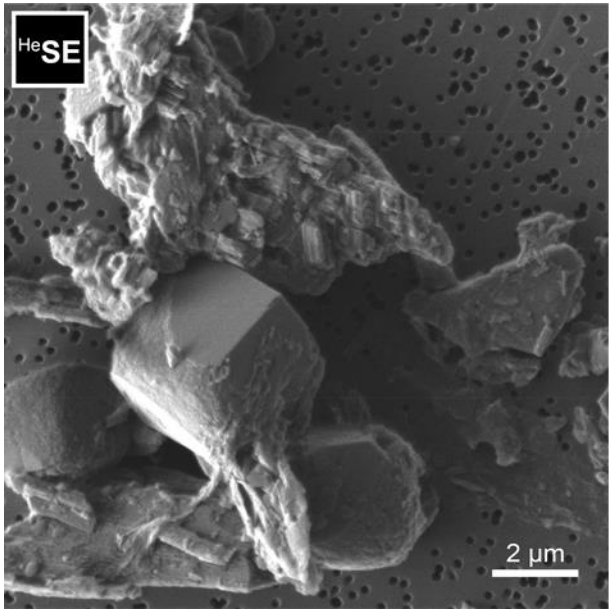


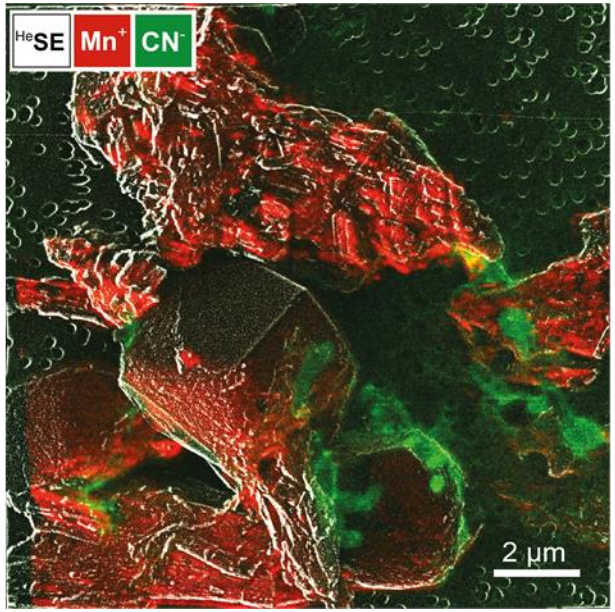


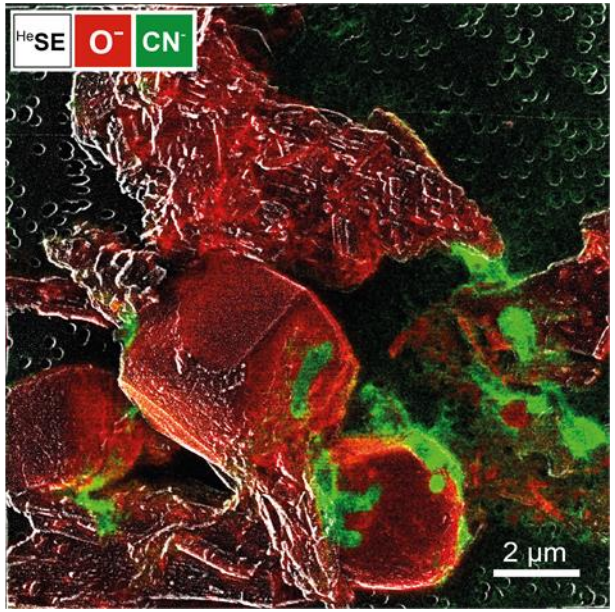


SIMS
20 keV Ne^+ / I_p=5 pA
512×512 pixels
3 ms/pixel
FoV 5×5 µm²

APPLICATION
LOCALISATION OF BACTERIA ON MANGANESE SPECIES







THANK YOU

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np SCOPE

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ZEISS PHOTONIS

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vito vision on technology

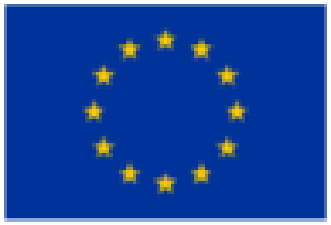
HZDR

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

MJR PharmJet GmbH

HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

Toxalim RESEARCH CENTRE IN FOOD TOXICOLOGY



The nanoparticle-scope (npSCOPE) project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 720964

https://www.npscope.eu/