

fit4nano

Newsletter # 3 - November 2023

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CONTENT

Editorial

Warm greetings to all FIT4NANO members and enthusiasts, feel very welcome to our 3rd Newsletter. In this issue, we recap main activities and outcomes related to the previous GP and provide basic information on the coming activities and planning for the current GP, which is the last for this COST project. First, our Action Chair delivers some general briefing. Then, you will be able to learn about the workshops we held for the different WGs of the Action, as well as summary of the general Workshop that gathered the FIT4NANO community in Lisbon last July. Please enjoy the nice scientific and personal experiences resulting from several STSM reports which are shared by some of the young fellows. Take some time to check our featured article related to the FIT4NANO Action, and very importantly, do not miss the announcements in running calls and the many coming activities

Gemma Rius, Institute of Microelectronics of Barcelona (IMB-CNM-CSIC)



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fit4nano project news

Report from Gregor Hlawacek, Action Chair of FIT4NANO

Welcome to the final grant period of FIT4NANO and welcome to a new future for Focused Ion Beams in Europe. The last grant period has been marked by our annual workshop and MC meeting in Lisbon. We had an exciting meeting with many collaborations hosted by an unusual partner. We hope that thanks to the organization by the Faculty of Pharmacy at the University of Lisbon we have sparked ideas for new application and maybe also collaborations in the medical and biological field. However, this hasn't been the end of the networking activities as two more meetings have been organized by WG1 Instrumentation (LIST Luxembourg) and WG3 Applications of FIBs together with WG4 Outreach (University of Albania, Tirana). Both workshops were streamed and reached a significant number of FIT4NANO members as well as friends around the globe.

Probably the most important result of GP3 is the final submission and acceptance for the FIB roadmap by the AIP Journal Applied Physics Reviews. A great thanks to Katja Höflich and all the co-authors in particular Frances Allen (UC Berkeley) and Lisa McElwee-White (University of Florida) for improving the scientific coherence and language of the entire document. The impressive statistical facts about the paper include 73 pages of high quality review and outlook, 34 figures, 9 comprehensive tables, and 1197 references, which take up 34 pages.

GP4 will focus on spreading the word about the roadmap (and making the tables and figures available online) as well as the production of a video explaining the fundamentals of FIB and how they enable processing analysis in current and future challenges at the nanoscale. We hope that the video will be particularly useful in combination with nearly finished high school materials (additional volunteers wanted).

You will get the chance to review this materials and network with the bigger FIB community in the combined FIT4NANO & Eu-F-N workshop, which will take place from 16-20 September in Albania. The meeting will facilitate the integration of these two groups of researchers to form a strong and sustainable future under the umbrella of the Eu-F-N after FIT4NANO has unfortunately ended in 2024. We hope to see you all there and at the future Eu-F-N workshops. As in the past years, we are striving to be able to support all active participants in their travel related expenses. In addition, we will hold a summer school in Switzerland, which will be organized by EMPA Thun and the Hochschule Veig. To enable intense collaboration, we are also planning small workshops, which will be streamed on workgroup specific topics. Please contact your WG leader in case you have ideas for topics or venues. Additional webinars on STSM results and role model presentations will be announced throughout the year.

Lets all work together to in building a strong and sustainable community to promote the development of FIBS and their application to micro and nanoscale challenges.

Happy FIBing,
Gregor

ITC Conference Grant Call & STSM Call

ITC conference grants support Young Researcher and Innovators from participating [ITC](#) to attend FIT4NANO related conferences or events not organized by the COST Action. In 2024, FIT4NANO would like to be represented at [EIPBN67](#) in La Jolla, CA, USA (28-31 May - *abstract submission deadline is 12 January!*) and at the FIB relevant session/symposia of [M&M 2024](#) (28 July - 01 August in Cleveland, OH, USA) and [EMC2024](#) (25-30 August in Copenhagen, Denmark).

We offer several ITC Grants to support your travel and participation. The grants are not limited to the aforementioned conferences. Please remember to acknowledge FIT4NANO in the abstract and your presentation. Both poster and oral presentations are eligible.

Applications in e-COST are accepted continuously until the available budget has been spent. If you are planning on submitting an application this GP, we would appreciate receiving a short declaration of intent from you via [e-mail](#) before 1 January 2024.

The deadline for the STSM call just passed and applicants will be informed about their grants before Christmas.

We will accept further STSM grant applications throughout GP4 until our available budget is used up. Applications will be reviewed and assessed in the order they are submitted.

All information and rules concerning STSMs can be found at <https://fit4nano.eu/stsm/>



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New Science Communication Officer

Genta Rexha, Polytechnic University of Tirana and Barleti University, Albania, took over the role of SCO.



© G. Rexha

FIT4NANO Grant Period 4

The 4th Grant Period began on 1 November 2023 and will end on 14 October 2024. This is also the end date of the FIT4NANO Cost Action.

FIT4NANO Video Clip

Task Force created

Amaia Sáenz Hernández and Alix Tatiana Escalante Quiceno, both from Universidad de Zaragoza, and Thomas Löber, TU Kaiserslautern, are working on the FIT4NANO outreach video clip in GP4. The video is set to be published by October 2024.

LUXEMBOURG
INSTITUTE OF SCIENCE
AND TECHNOLOGY

Working Group 1 Meeting: workshop on novel developments and detectors for nano-imaging and nano-analysis

Organizers:

Dr. Hung Hoang, Luxembourg Institute of Science and Technology
Dr. Olivier De Castro, Luxembourg Institute of Science and Technology
Dr. Tom Wirtz, Luxembourg Institute of Science and Technology
Dr. Gregor Hlawacek, chair of the COST Action FIT4NANO

The workshop was organized as part of the FIT4NANO COST Action, WG1-Tool Development from 9-10 October 2023 in Le Fonds Belval, Luxembourg, and was dedicated to novel instrumentation and methodologies developments for nano-imaging and nano-analysis. While this workshop covered all aspects of instrument development related to focused ion beams, a major focus was on advanced charged particle detectors with better sensitivity, higher spatial resolution, higher dynamic range, longer lifetime, lower cost, etc., for advanced nano-analytical instruments. The list of topics included novel ion source concepts and technology, ion optical designs, novel spectrometers and, importantly, state-of-the-art detectors for ion/electron beam analytical instruments.



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All in all, there were 13 oral contributions, including 5 invited talks given by Dr. Pasqual Bernhard, Surface Concept GmbH, DE; Prof. Ron Heeren, Maastricht MultiModal Molecular Imaging Institute – M4I, Maastricht University, NL; Prof. Anjam Khursheed, Polytechnic University of Milan, IT; Dr. Serge Duarte Pinto, Photonis, NL; and Dr. Julian Schmehr, X-spectrum GmbH, DE.



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Working Groups 3 & 4 Meeting: Application of FIBs and Roadmap communication

Organizers

Katja Höflich, FIT4NANO WG3 leader, Ferdinand-Braun-Institut gGmbH, Leibniz-Institut fuer Hoehstfrequenztechnik

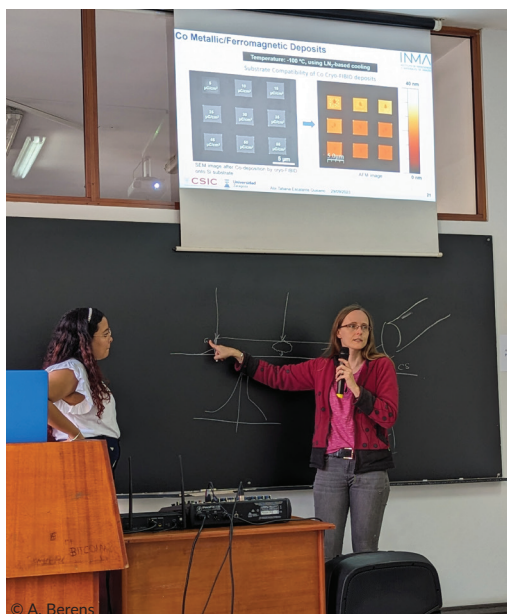
Genta Rexha, FIT4NANO Science Communication Officer, Albanian University

Delina Xhafaj, FIT4NANO Action Member, Albanian University

The meeting was organized as part of the FIT4NANO COST Action, WG3-FIB applications, and WG4-Communications & Outreach, on September 29th, 2023, at Albanian University in Tirana, Albania, and was dedicated to Application of FIBs and Roadmap communication. The focus of the workshop was on defect engineering/SII, tomography of energy materials and machine learning, unconventional processing, advanced FIB processing in industry, FIB processing of radioactive samples, cryo tomography of biological samples, heterogeneous integration, roadmap advertising.

There were 5 oral contributions, given by **Mateus Gallucci Masteghin**, University of Surrey, UK; **Alix-Tatiana Escalante-Quiceno**, Universidad de Zaragoza, Spain; **Grzegorz Cempura**, AGH University of Science and Technology, Poland; **Wiebke Möbius**, Max Planck Institute for Multidisciplinary Sciences, Germany; **Sara Novak & Valentina Perc**, University of Ljubljana, Slovenia.

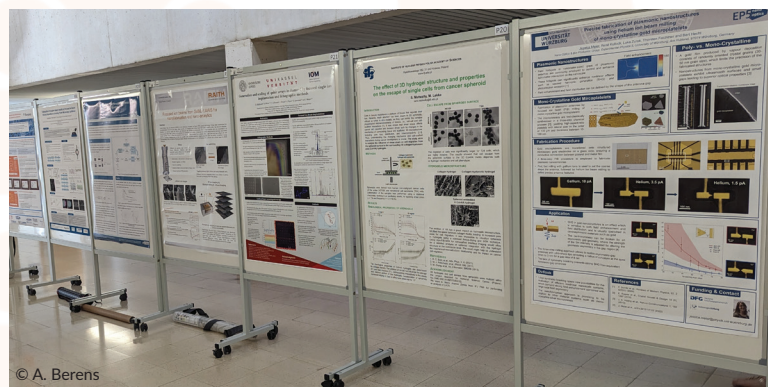
The workshop concluded with a discussion on the Road Map Advertising and the WG4 meeting on the preparation of High School Material and Video Clip.

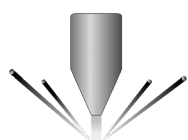


fit4nano project news

Impressions from the FIT4NANO Workshop 2023

The 3rd FIT4NANO Workshop took place from 17-19 July at the Faculty of Pharmacy of the University of Lisbon. Around 130 participants from Europe, Asia, North America, and Australia, joined us in Portugal for 34 oral and 38 poster presentations. The workshop was enriched with social activities, such as performances by student music groups including the female tuna group of the Faculdade de Farmácia (<https://youtube.com/@TunaAFeminina>), who serenaded us after the first day of presentations.















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STSM & other grants

Overview of Short-Term Scientific Missions in GP3

GP 3 ran from 01 November 2022 to 31 October 2023. In total, 11 STSM applications were approved, of which 10 actually took place:

-  Alba Arroyo-Fructuoso, **Design and nanofabrication of advanced superconducting nanostructures and devices using Focused Ion Beams**, Institute of molecular science (ICMol), Spain, to HZDR, Germany (8 days)
-  Tatiana Escalante Quiceno, **Helium Focused Ion Beam irradiation to improve the resolution of MFM tips grown by FEBID and to change the local magnetic state**, Universidad de Zaragoza, Spain, to HZDR, Germany (33 days)
-  Meltem Sezen, **A Comparative Study for Rb⁺ vs Ga⁺ Ion Implantation Rate in Biocompatible Materials**, Sabanci University, Turkey, to TU Eindhoven, Netherlands (5 days)
-  Feray Bakan, **Examination of spraying effect during Rubidium / Gallium FIB deposition for different material surfaces**, SUNUM, Turkey, to TU Eindhoven, Netherlands (5 days)
-  Alba Salvador Porroche, **Synthesis of organometallic precursors for direct-writing fabrication**, Instituto de Nanociencia y Materiales de Aragon (INMA), Zaragoza, Spain, to Goethe University Frankfurt, Germany (21 days)
-  Bartosz Pruchnik, **Focused ion beam for modification of active cantilevers for high-speed metrology of 2D materials**, Wroclaw University of Science and Technology, Poland, to University of Surrey, UK (14 days)
-  Krzysztof Kwoka, **Investigations of vacuum electronics nanodevices fabricated and/or modified using focused ion beam technologies**, Wroclaw University of Science and Technology, Poland, to HZDR, Germany (5 days)
-  Aleksei Tsarapkin, **TOF-SIMS for in-situ analysis of thin Au films grown by electron-assisted CVD**, Ferdinand-Braun-Institute, Germany, to EMPA, Switzerland (19 days)
-  Ewelina Gacka, **Investigating the application of FIBID W(C) nanowires as field emitters**, Wroclaw University of Science and Technology, Poland, to HZDR, Germany (13 days)
-  Aleksandra Butrymowicz-Kubiak, **Improvements of FEBID/FIBID potential new precursors of palladium and copper containing O,O-donor ligands**, Nicolaus Copernicus University, Poland, to EMPA (14 days)

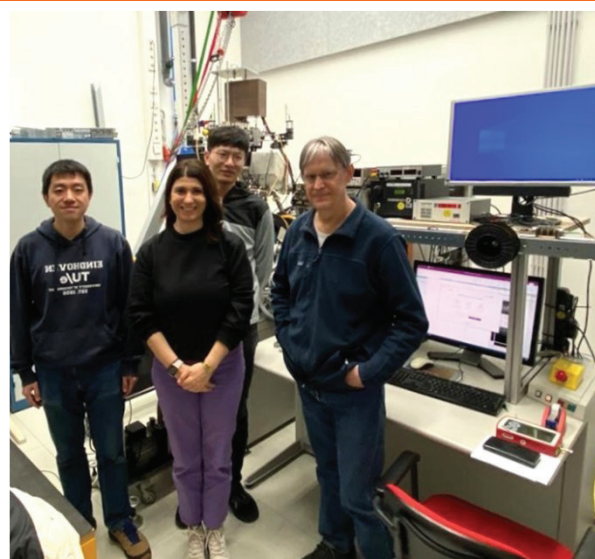
STSM Report by Meltem Sezen

Sabanci University - SUNUM, Turkey. April 2023

Between 24-28 April 2023, I have visited Eindhoven University of Technology (TU/e) in the scope of STSM programme, provided by FIT4NANO COST Action (CA19140). The mission of my STSM hosted by Dr. Edgar Vredenburg at TU/e was to conduct test experiments on their newly designed & developed ultra-cold rubidium focused ion beam (FIB) system.

The pilot Rb-FIB system (build up in collaboration with Thermo Fisher Scientific Company) at TU/e has an Atomic Beam Laser-cooled Ion Source (ABLIS) which uses ultracold rubidium ions. Accordingly, the use of the focused Rb⁺ ion beams is expected to show remarkable differences when compared to the other sources, e.g. Ga⁺ and He. This system is capable of ion-milling, as well metal deposition at the sample which is possible by the use of Gas Injection Systems (GIS) similar to that are being used in conventional FIB tools.

The STSM aimed to investigate the ion implantation caused by Rb⁺ and Ga⁺ ions comparatively on soft and hard



Dr. Vredenburg's Rb-FIB Lab at TU Eindhoven © M. Sezen

biomaterial samples (ceramic, polymer) in order to check the dependency of both ion species and material nature,

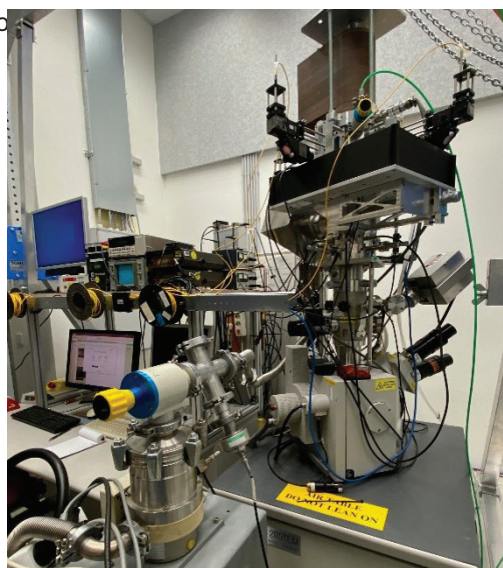


STSM & other grants

by examining the implantation rate. In this collaborative work, a variety of hard and soft materials, e.g. ceramic and polymer samples were exposed to ion milling patterns with varying doses. The implantation tendency as a result of sputtering/ ion milling were then determined by SEM-EDS analyses at SUNUM Labs by Dr. Sezen, providing useful quantitative data and qualitative information for different material surfaces.

Thanks to the FIT4NANO COST Action and Dr. Vredenburg, the ongoing collaboration and networking between Sabanci University - SUNUM and TU Eindhoven will actively be in progress for our future research. Dr. Vredenburg and his group provided us the opportunity to use their newly designed Rubidium FIB system and many processing options with their friendly hosting and valuable know-how transfer. For the next steps of our mutual research, we plan to concentrate on the Rb-ion cross-sectioning trials for very soft and susceptible materials: such as rubber and

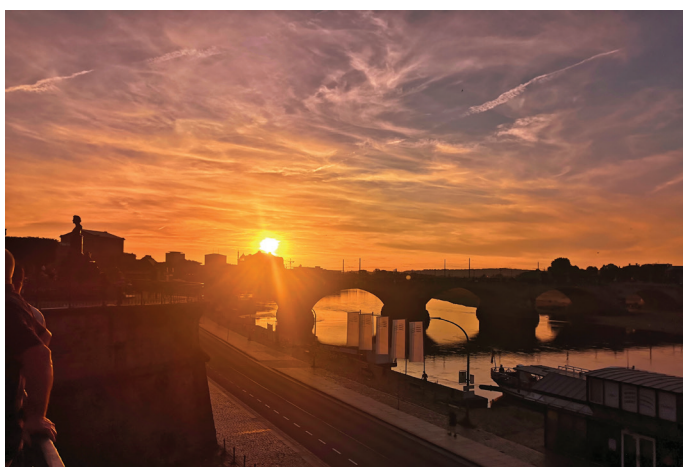
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Rb-FIB system at TU Eindhoven © M. Sezen

STSM Report by Krzysztof Kwoka

Department of Nanometrology, Wrocław University of Science and Technology, Poland. August 2023

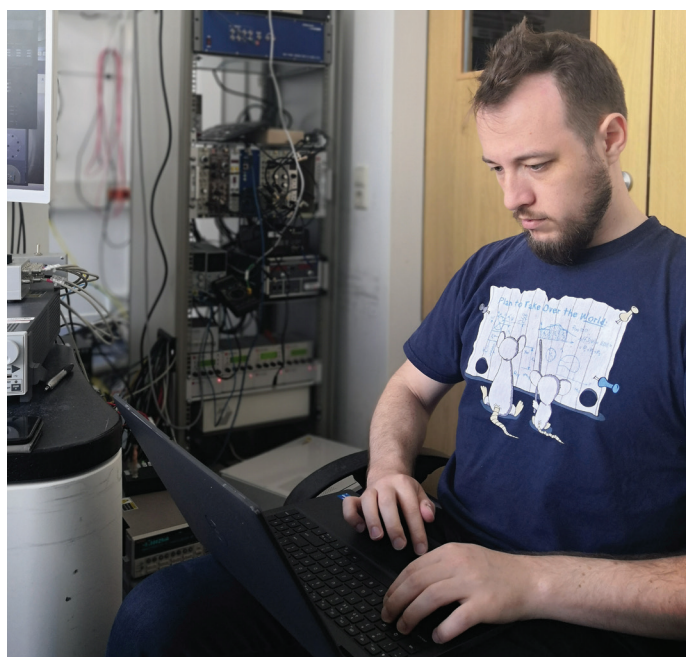


Above: Dresden sunset. Right: working in the lab © K. Kwoka

My visit to Helmholtz-Zentrum Dresden-Rossendorf was inspired by my teammate's (Ewelina Gacka) earlier activities during STSM in Dresden. The Institute of Ion-Induced Nanostructures is equipped with a unique helium ion microscope, which allows non-electrically conductive modification of micro- and nanostructures and their fabrication. Its use was required for a series of experiments related to field emission at the nanoscale.

Unfortunately, prior to my visit, the microscope had malfunctioned so the planned experiments could not be carried out. During my stay in Dresden, instead, I had the opportunity to become better acquainted with the design of the microscope itself and to prepare measurement software for the accompanying source measuring unit.

I hope I will still have the opportunity to work with Dr.



Hlawacek in the future to conduct the experiments that were originally planned. He is a very kind and always supportive head of the group, with whom you can chat not only about academic matters!

I also took the opportunity to take a partial tour of the city. Dresden is a beautiful riverside city with a historic city center worth seeing. Numerous restaurants offer delicious food, and evening life is thriving.

I highly recommend HZDR as a place to participate in STSM!

STSM in Frankfurt by Alba Salvador Porroche

Instituto de Nanociencia y Materiales de Aragon (INMA), Spain. June 2023

For three weeks in June, I had the opportunity to visit Sven Barth's group at the Goethe University in Frankfurt, Germany.

In my PhD, I am working on the fabrication of metallic structures by fragmentation of organometallic precursors using focused electron and ion beams. As a chemist, I was curious to know how these types of precursors are synthesized, and I chose to work with this group due to their high expertise in the field.

One of the objectives of this stay was to synthesize Ag-based precursors by Schlenk techniques which will be employed to fabricate metallic deposits from spin-coated layers using focused electron and ion beams. This part will be carried out in Zaragoza, as an on-going collaboration between both groups.

The other objective was to fabricate FeSix deposits by FIBID using a highly sensitive single-source precursor in order to study how the ion beam parameters influence the elemental composition. The crystallinity and microstructure of selected deposits will be characterized by TEM in Zaragoza.

From my point of view, the biggest success was learning to use Schlenk techniques which gave me practical training in handling other sensitive precursors in the future. In addition, the on-going collaboration with Sven Barth's group opens up a range of possibilities for the study of new materials with a lot of interesting properties.

In addition to the scientific mission, I was able to visit Frankfurt and its surroundings during my stay. Frankfurt

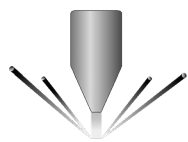


© A. Porroche

is not only one of the most important financial centers in Europe, but it also has a small historic center, rebuilt between 2012 and 2018, which is ideal for strolling through its colorful houses and enjoying its wide gastronomy. Just an hour by train from Frankfurt, the city of Heidelberg lies between opposite slopes where the Neckar River empties into the Rhine Valley. Aside from its wonderful views, this romantic city is home to the oldest University of Germany, founded in 1386, where the youthful atmosphere prevails. I would certainly repeat this experience and encourage everyone to live it, since it not only allows you to get to know other research institutions and learn from their way of working, but it is also very enriching on a personal level. Finally, I would like to thank Sven Barth and his students, Nico and Vanessa, for their kindness during my stay and STMS committee for facilitating exchange visits for researchers.



© A. Porroche



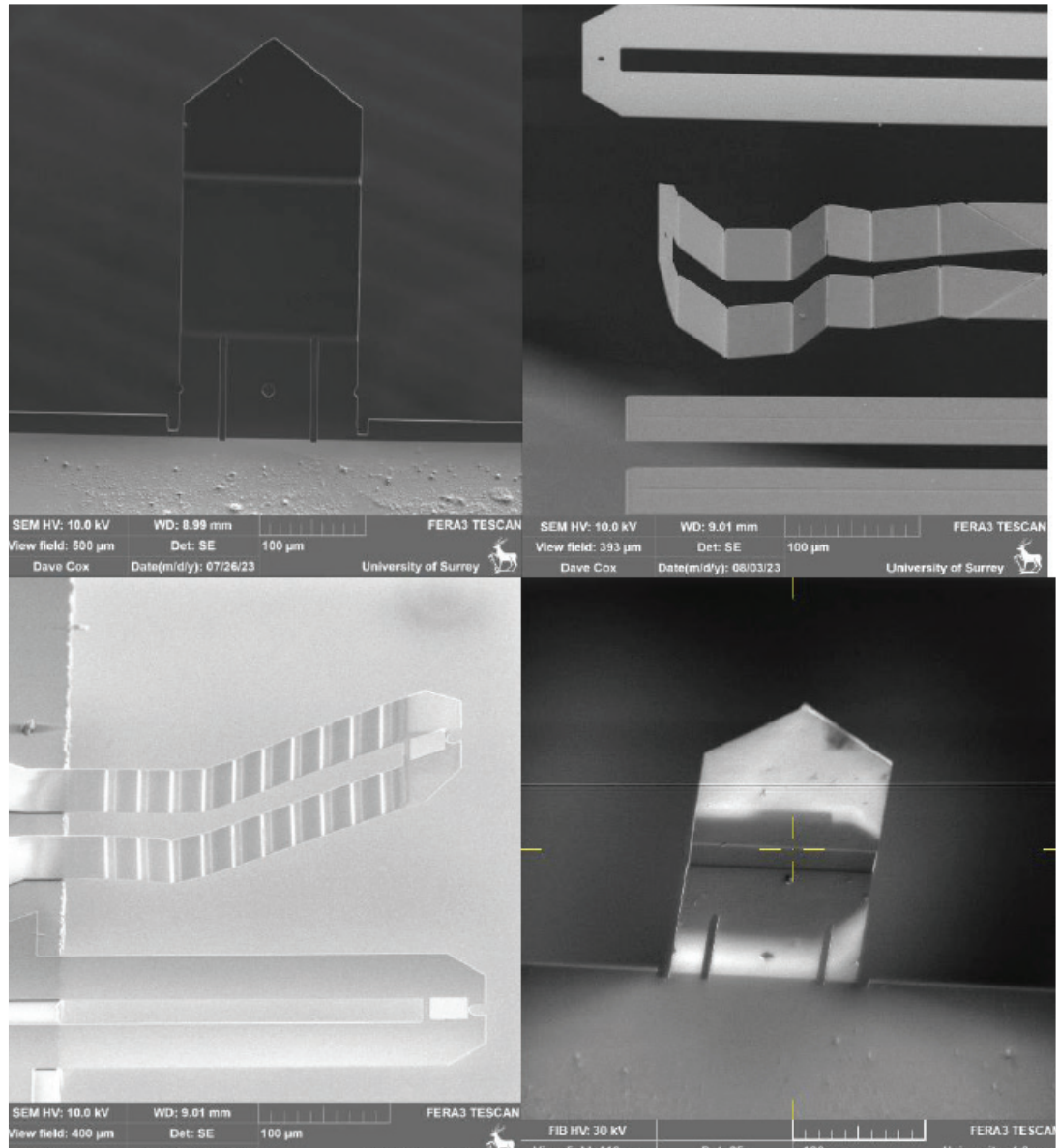
STSM Report by Bartosz Pruchnik *Wroclaw University, Poland - July 23*

The aim of my STSM at the University of Surrey was to modify active piezo-cantilevers in order to enhance higher eigenmodes generation – second or third longitudinal modes were chosen.

Before the main experiment performance, cantilevers were measured with SIOS laser interferometric vibrometer in order to assess exact parameters prior to any modification.

Secondly, cantilevers were measured with Tescan FERA3 SEM. Data served as an input to the FEM model in Comsol Multiphysics package, with which accurate prediction of shapes of further eigenmodes was performed.

Cantilevers then were modified with Tescan FERA3 xenon FIB in order to induce eigenstress in the region of augmented stress during actuation (in the standing wave antinode). Stress inducing was tried with amorphisation of the surface, with slight etching of the surface and deep (up to half of the thickness of the cantilever) etching.



© B. Pruchnik

The main results of the STSM are four active piezocantilevers modified in order to amplify amplitudes of deflection in higher eigenmodes. Mechanical properties will be carefully measured and compared with pre-modified ones. Modified cantilevers will be used in high-speed atomic force microscope in non-contact mode. Expected result of application is wider range of measurement in Z direction (sample height), which is main limitation of currently used multimode microscopes. Simultaneously, cantilevers with amplified efficiency of actuation at higher eigenmodes will have elevated sensitivity in applications like force sensing, viscosity measurements, mass measurements etc.

Several series of modifications were also done on different devices with altering total dose, energy, area dose and patterns. Resultant strain sign depends on few factors, including beam parameters, surface material and crystallinity level and ion dose. It may then be used to induce structural rigidity in flat (sheet) structure. Two series of cantilevers were modified in order to examine the stiffness change after modification. Preliminary results show, that modification may lead to increase in cantilever stiffness without alteration of its electrical parameters.



STSM & other grants

Report by Feray Bakan Misirlioglu *Sabanci University- SUNU, Turkey - April 23*

From 24th to 28th April 2023, I visited Eindhoven University of Technology (TU/e) as part of the STSM program facilitated by FIT4NANO COST Action (CA19140). The objective of my STSM, led by Dr. Edgar Vredenburg at TU/e, was to examine the spraying effects of Rb- vs. Ga-FIBID experiments on different biomaterial samples on their recently designed and developed ultra-cold rubidium-focused ion beam (FIB) system. This novel FIB system has an Atomic Beam Laser-cooled Ion Source (ABLIS), which uses ultra-cold rubidium ions. Rb ions are expected to have diverse applications in various fields of science and technology when used in FIB technologies due to their unique properties. However, due to the recent relocation of Dr. Vredenburg's laboratory to a new facility, the Rb-FIB system was not operational during my visit. Consequently, the primary challenge arose from the inability to conduct the planned experimental studies as initially intended. After discussions with Dr. Vredenburg, we decided to use this time slot to analyze the morphological properties of Pt deposits on Si substrates by considering their AFM measurements.

Through my experience, I learned that the STSM fosters scientific collaboration among diverse research groups and



© F. Bakan Misirlioglu

facilitates professional and personal growth by introducing individuals to new situations and experiences during their stay. Lastly, I would like to thank Edgar Vredenburg, Yang Li, and Sheng Xu for their kind support during my visit. In our upcoming research, we intend to conduct Rb-ion deposition experiments tailored explicitly for hard and soft biomaterials.

STSM Report by Aleksandra Butrymowicz-Kubiak*Nicolaus Copernicus University, Poland - October 23*

I had the opportunity to visit the Swiss Federal Institute for Materials Science and Technology (EMPA) in Thun, Switzerland. The main aim of my research during the STSM was to perform FEBID tests for new palladium and copper precursors, pre-select process conditions and obtain deposits as part of a project entitled: "Improvements of FEBID/FIBID potential new precursors of palladium and copper containing O,O-donor ligands" which was supervised by Dr. Ivo Utke.

During the two-week visit, I had the opportunity to have a look at the experimental FEBID. In addition, I was able to see how changes to individual parameters can have an impact on the quality of the deposits that are produced. Importantly, during STSM I was able to test in FEBID the new complexes I had synthesised as part of my doctoral research. Thanks to the COST Action for the STSM grant.

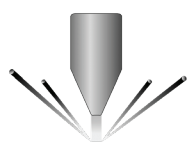
The STSM gave me the opportunity to explore the

charming city of Thun, which is located at the end of the lake Thunersee. There is no doubt that the emerald-green river Aare that flows through the city and the Alps that surround Thun also add to its charm.

I would like to thank Ivo Utke, Krzysztof Maćkosz and Chinmai Sai Jureddy for their collaboration, support and kindness during my stay in Thun.



© A. Butrymowicz-Kubiak



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STSM & other grants

STSM Report by Ewelina Gacka *Wroclaw University, Poland - October 23*

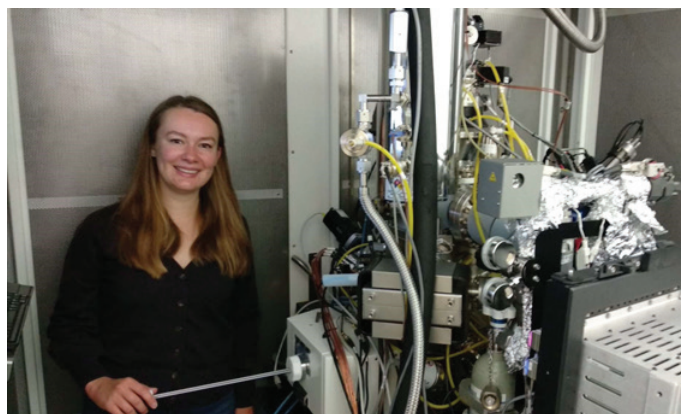


Between 15th and 18th of October 2023 I had the opportunity to realize STSM project entitled “Investigating the application of FIBID W(C) nanowires as field emitters”. The host was Dr. Gregor Hlawacek. During my Ph.D., I am working on the fabrication of field emitters using a scanning electron microscope with a focused ion beam. Therefore, the choice of the Helmholtz-Zentrum Dresden Rossendorf (Germany) was reasonable due to the possibility of depositing such structures using a helium ion microscope and a tungsten precursor. This step was undertaken to consider whether it is possible to improve the efficiency of operation of nanowire field emitters by using a helium ion beam instead of a gallium ion or electron beam.

During first week, together with Dr. Gregor Hlawacek, we spent majority of the time calibrating the nanowire growth to integrate nanowire field emitters with microelectromechanical systems, like microcantilevers. A batch of field emitters were fabricated along with measurement of their current-voltage characteristics. The stability of field emission current was also considered. In the second week, a number of service procedures were undertaken to maintain the helium ion microscope, such as creating a trimer at the end of the tungsten needle, plasma cleaning of the chamber, calibrating the helium gas flow and baking the ion column. During this stages, the operation of the microscope was discontinued. Nonetheless, it was a great opportunity to learn how to solve some of the problems associated with helium ion microscopes. In order to complete all the scheduled tasks, I plan to continue the collaboration on fabricating nanowire field emitters and

measuring their properties. It would also be interesting to try to prototype a new type of displacement sensor based on the field emission phenomenon as a next step.

In conclusion, I would like to thank Dr. Gregor Hlawacek and Amina Zid for their time. I would recommend undertaking STSM to any researcher, as it gives the opportunity to collaborate with different institutes and improve professional skills. In the meantime, it is also a chance to visit new places. In my case, during the weekend I went hiking in the mountains of Saxon Switzerland, cycled along the Elbe River and saw the old town of Dresden, which I heartily recommend.



© all photos: E. Gacka



fit4nano member news

Collaboration between Eindhoven University of Technology (TU/e), the Netherlands, and TU Kaiserslautern, Germany

by Yang Li, Eindhoven University of Technology

Between July 12-14, 2023, Dr. Vredenburg and I visited the Nano Structuring Center of the University of Kaiserslautern-Landau (RPTU) in Kaiserslautern, Germany. The visit was hosted by Dr. Thomas Löber. The goal of this visit was to use the Zerok Cs-FIB for application studies on ion-induced secondary yields and platinum deposition (FIBID-Pt). There is a prototype rubidium FIB based on laser-cooled atoms at TU/e. Several studies have been conducted to examine the applications of the ultracold Rb-FIB. It is interesting to us to perform parallel experiments on the Cs-FIB, which is also based on laser-cooled Cs atoms, to compare the two ion species.

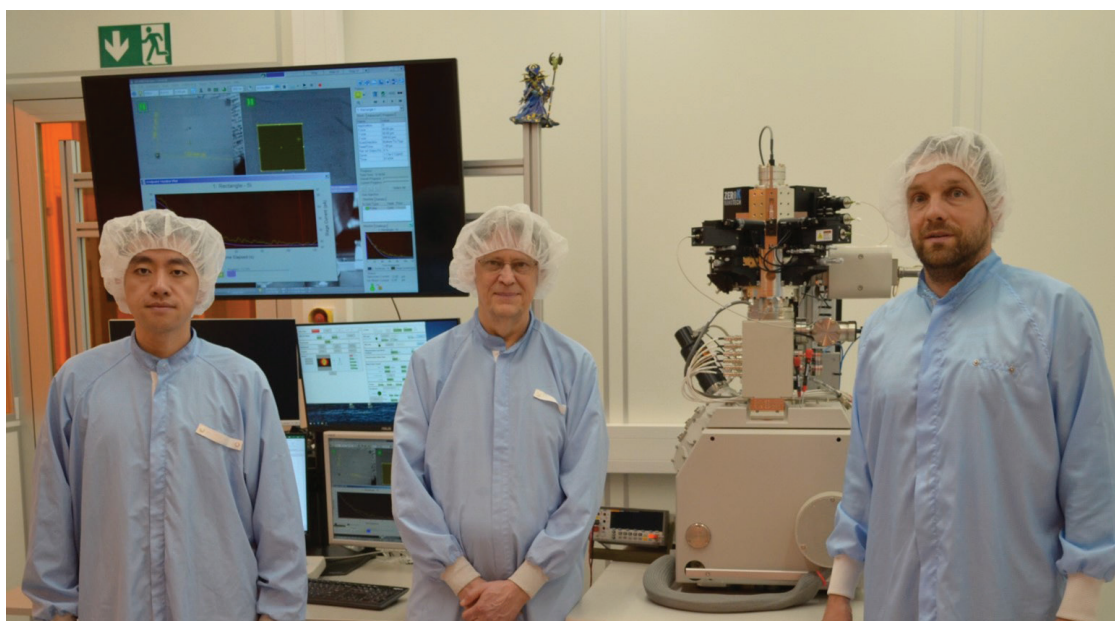


Photo taken during Dr. Vredenburg and Yang Li's visit to RPTU and Dr. Löber's Cs-FIB Lab © Y. Li

During the visit, Cs-FIB processed samples were successfully fabricated. These samples include Cs⁺ ions irradiated silicon and Cs⁺ FIBID-Pt. Sample characterization was later performed both at the Sabanci University Nanotechnology Research and Application Center (SUNUM) in Turkey and at TU/e. The SUNUM experiments were facilitated by Dr. Bakan Misirlioglu and Dr. Sezen. Sample characterization such as TEM imaging, TEM-EDS, and resistivity measurements can provide the data needed for understanding the difference between Rb⁺ and Cs⁺ ions from a FIB application perspective.

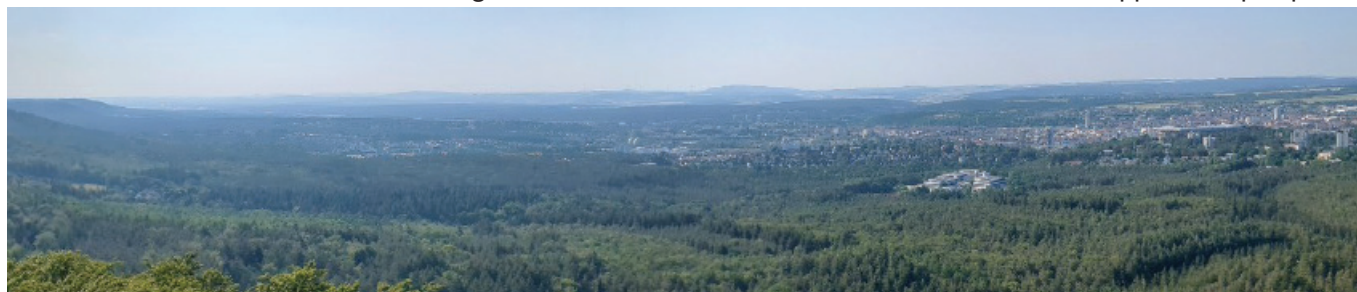


Photo taken from Humbergturm during a hiking tour © Y. Li

In addition to working with Dr. Löber in his laboratory, Dr. Vredenburg and I were also able to explore the beautiful forests and mountains surrounding the university. During one of our hiking trips, we visited the Humbergturm, which offers a panoramic view of the whole Kaiserslautern area. Besides the advanced equipment at RPTU, Kaiserslautern has a lot to offer in terms of outdoor activities.

Thanks to the FIT4NANO network for connecting us with the Kaiserslautern and the SUNUM group. The visit was both productive and enjoyable. I feel very fortunate to benefit from this network and to make use of research resources from three different countries. Dr. Vredenburg and I would also like to thank Dr. Löber for hosting and for the collaboration.



fit4nano member news

Doctoral thesis of Dr. Bernd Aichner honored by the Austrian Physical Society (ÖPG)



Dr. Bernd Aichner received the prize of the Condensed Matter Division of the Austrian Physical Society (ÖPG) for his doctoral thesis:

“Vortex Dynamics in Copper-Oxide Superconductors with Periodic Pinning Potentials Created by Focused Helium Ion Beam Irradiation”

The prize was awarded during the Joint Annual Meeting of the Austrian and the Swiss Physical Societies on 5 September 2023 in Basel.

FIT4NANO congratulates its member on this big success!

New publications



B. Aichner, L. Backmeister, M. Karrer, K. Wurster, R. Kleiner, E. Goldobin, D. Koelle and Wolfgang Lang, Angle-dependent Magnetoresistance of an Ordered Bose Glass of Vortices in YBa₂Cu₃O₇-delta Thin Films with a Periodic Pinning Lattice, *Condens. Matter* 2023, 8(2), 32 [DOI](#)



R. M. Bradley, Gerhard Hobler, Sputter yields of surfaces with nanoscale textures: Analytical results and Monte Carlo simulations, *Journal of Applied Physics* 133, 065303 (2023) [DOI](#)



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Universal radiation tolerant semiconductor

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Radiation tolerance is determined as an ability of crystalline materials to withstand the accumulation of the radiation induced disorder. Based on the magnitudes of such disorder levels, materials are commonly grouped into the low- or high-radiation tolerant. Nevertheless, upon exposing to sufficiently high fluences, in all cases known by far, it ends up with either extremely high disorder levels or amorphization. In our recent work [1], we show that γ/β double polymorph Ga_2O_3 structures exhibit unprecedentedly high radiation tolerance. Specifically, for room temperature experiments, they tolerate a disorder equivalent to hundreds of displacements per atom, without severe degradations of crystallinity; in comparison with, e.g., Si amorphizable already with the lattice atoms displaced just once, see Fig.1.

We explain this behavior by an interesting combination of the Ga- and O-sublattice properties in $\gamma\text{-Ga}_2\text{O}_3$. In particular, O-sublattice exhibits a strong recrystallization trend to recover the face-centered-cubic stacking despite high mobility of O atoms in collision cascades compared to Ga. Concurrently, the characteristic structure of the Ga-sublattice is nearly insensitive to the accumulated disorder. Jointly it explains macroscopically negligible structural deformations in $\gamma\text{-Ga}_2\text{O}_3$ observed in our experiments [1]. Additionally, we explained the origin of the β -to- γ Ga_2O_3 transformation and studied the phenomena as a function of the chemical nature of the implanted atoms. As a result, we conclude that γ/β double polymorph Ga_2O_3 structures, in terms of their radiation tolerance properties, benchmark a new class of supreme radiation tolerant materials.

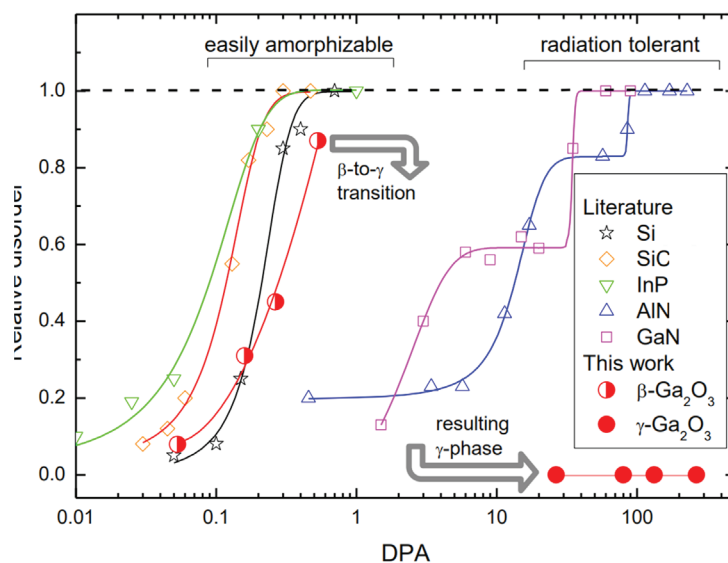


Fig.1. Comparison of the experimental data on relative disorder in Ga_2O_3 with literature data for easily amorphizable and radiation tolerant materials, plotted as a function of the displacements per atom (DPA). We collected the data from Ga_2O_3 samples irradiated by several different ions, e.g. Ga, Ne, Ni, and Au at room temperature using Rutherford Backscattering Spectroscopy in channeling mode (RBS/C) and verified it by Transmission Electron Microscopy (TEM). As guided by arrows in the figure, we started from $\beta\text{-Ga}_2\text{O}_3$ and revealed a swift disorder accumulation. However, not resulting in the full amorphization of $\beta\text{-Ga}_2\text{O}_3$, but triggering its transformation to a new crystalline $\gamma\text{-Ga}_2\text{O}_3$ polymorph. From this stage, the DPA increase had no effect and the crystallinity of the $\gamma\text{-Ga}_2\text{O}_3$ remained unchanged.

The work is a result of a m-era.net project between three different FIT4NANO partners. The network acted as facilitator for the initial connection between the partners.

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DOI: <https://doi.org/10.1038/s41467-023-40588-0>



events

HZDR lecture series “Materials Science Using Ions” - Fridays from 1-2:30 p.m. CET

HZDR is offering a hybrid course on „Materials Science Using Ions“ every Friday from 1 to 2:30 p.m. CET, starting on November 10th. You are welcome to join any of the lectures.

01 December 2023	Shengqiang Zhou – Ion implantation for doping semiconductors
08 December 2023	Shengqiang Zhou – Ion Beam analysis for thin films: Rutherford backscattering
15 December 2023	Frans Munnik – Ion Beam analysis for thin films: particle induced x-ray emission
12 January 2024	Frans Munnik – Elastic Recoil Detection Analysis and nuclear reaction
19 January 2024	Gregor Hlawacek – Focused ion beams
26 January 2024	Arkady Krasheninnikov – Atomistic simulations of irradiation effects in solids
02 February 2024	Rantej Bali – Ion beam modification for magnetic materials
09 February 2024	Stefan Facsko – Ion beam modifications of surfaces and 2D materials
23 February 2024	Yonder Berencen – Ion beams for quantum technologies

The link for online participation is available at

<https://fit4nano.eu/hzdr-lecture-series-materials-science-using-ions/>

Role Model Webinar 2

After last Grant Period's successful role model webinar, where Action Members talked about the ups and downs of their careers in academia and industry, we decided to do a 2nd edition about (un)conventional career paths. Speakers will be from a variety of backgrounds, including science management and technology transfer. The one hour webinar will take place in February 2024.

FIT4NANO Summer School 2024

FIT4NANO will host its second summer school in Thun, Switzerland. The school is organized by Ivo Utke (Empa | Swiss Federal Laboratories for Materials Science and Technology) and Silvia Schintke (HEIG-VD / HES-SO, University of Applied Sciences Western Switzerland). Look forward to one week filled with FIB lectures and hands-on training. The school will most likely take place in mid-August; the exact dates and further information will be announced in December once we receive confirmation from the venue. The school's lectures can also be attended online.

4th FIT4NANO Workshop

The 2024 workshop will take place from 16 - 20 September in Dürres, Albania and is hosted by our SCO, Dr. Genta Rexha, Barleti University. As in GP1, the workshop will be co-organized with the European FIB Network Eu-F-N (<https://www.eu-f-n.org>). Expect four to five days of presentations, poster sessions and FIT4NANO Working Group meetings.

If you have questions, comments, or input for the next newsletter, please send an e-mail to Astrid at a.berens@hzdr.de

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