Issue # 7 - September 2022

Newsletter

RADIATE Midterm Meeting

Finally – after more than a year of delays due to COVID, the RADIATE midterm (can we still call it midterm?) meeting took place in Lisbon from 15-16 July. After many delays, the meeting was relocated from winter-y Vienna to sunny Lisbon to be adjacent to IBMM, which made more sense economically and environmentally since many project partners were attending IBMM anyway.

17 of the 19 partners sent at least one representative and in total around 50 people participated in the meeting. The meeting kicked off with a poster session on the Joint Research Activities (JRA) to bring all the partners and guests up to date, as JRA is slowly winding down as scheduled in the workplan (end of all JRA in December 2022).

During the midterm meeting, the progress of the project was discussed in parallel meetings of the user selection panel (USP), external advisory board (EAB), and the RADIATE general assembly. Remote participation was made possible for the USP and EAB members, who could not be there in presence.

Five selected transnational access users were invited to travel to Lisbon and present their research to the consortium to showcase the spectrum of transnational access users. Preliminary statements by the USP and EAB on the project ended the meeting. These statements will be discussed internally and will help improve RADIATE in its final year.

From page 6 onward, we will introduce some of the actors of RADIATE you usually do not hear so much about in the newsletter. We took the chance to interview some transnational access (TA) users, a USP member, and an industry partner for you.

Until next time!

RADIATE

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NEWSLETTER EDITORIAL

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Sign up for the bi-annual newsletter:
https://www.ionbeamcenters.eu/radiate/radiate-newsletter/

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Hybrid RADIATE Summer School on Environmental applications of IBA and AMS

Registration for online participation is still open

The RADIATE Summer School on 'Environmental applications of IBA and AMS' is organized by INFN in Florence, Italy. While applications for participation in presence cannot be accepted anymore, registration for online participation (5-6 October) is still open.

Planned lectures

Massimo Chiari INFN	Introduction to IBA techniques
Primoz Pelicon, JSI	IBA for plant biology
Silvia Nava INFN	IBA for climate change and air quality issues
Mariaelena Fedi, INFN	Introduction to AMS technique
Stephan Winkler, HZDR	Environmental applications of AMS
Konstanze Stübner, HZDR	Geological applications of AMS
Giulia Calzolai, INFN	^{14}C AMS in the study of atmospheric aerosols
Claudia Cocozza, University of Florence	Dendrochemistry with PIXE

More information here – https://www.ionbeamcenters.eu/radiate/training/radiate-summer-school/

RADIATE REPORT SERIES

A new RADIATE Report on "Increasing the negative ionization yield for the efficient detection of ^{233}U and ^{236}U by AMS" by Michael Kern, Karin Hain, Tomáš Prášek, Peter Steier, Andreas Wiederin and Robin Golser is available here – https://zenodo.org/record/6256795#.YheVspYxlPY

If you have results or documentation that you think might be suitable for the RADIATE Report Series, please contact the editor Ian Vickridge.

Surrey adopts imec's WASP software for data acquisition

At Surrey Ion Beam Centre, we have been developing our standard RBS offerings by extending our capabilities to carry out RBS-channelling. Our visit to KU Leuven and imec to learn more about the channelling technique is described in RADIATE Newsletter 1. Since that visit, we have successfully studied dilute bismuth III-V alloys (InGaAsBi) and are extending our studies to other materials such as SiC.

We have upgraded our data acquisition with modern Caen digital units, our charge measurement system to a Pyramid I404 and goniometer with Galil motor controllers. This new equipment put the onus on the need for new software. Our pre-upgrade software was written in Visual Basic 6 which is no longer supported and so we decided to modernise and standardise our software across the laboratory. We have been using OMDAQ software very successfully for many years in our nanobeam equipment in high resolution spatial mapping experiments and so it seemed logical to standardise to OMDAQ for our RBS measurements.

However, without a major software resource, this approach has proven to be problematic as the code has been difficult to modify to control the new RBS equipment.

We believe the solution to our software control problem appeared in RADIATE Newsletter 5 which contained an article describing the modular software WASP, developed within the Joint Research Activity 22.3. This JRA, exploring the use of multi-detectors to increase the competitive usage of accelerators in materials science, contains a central theme that RBS analysis throughput can be improved most cost effectively by increasing the collection efficiency of the scattered signal using multiple detectors. The use of multiple detectors generates the need for software that can be applied in different laboratories that have different hardware but does not require a dedicated software programmer in each location. Hence the development of WASP at imec by Michiel Jordens, Praveen Dara and Johan Meersschaut. A library of WASP modules ("daemons") have been written by a dedicated programmer (Michiel) that communicate to hardware devices such as detector acquisition electronics, beam charge monitors and sample goniometers. The user can then write scripts in Python that use the daemons appropriate to the equipment in the laboratory to control IBA measurements. Since Python is a widespread language, writing scripts is within the capabilities of a non-dedicated programmer.

TOF-ERDA installed and working at Surrey!

The Surrey Ion Beam Centre (SIBC) has a new time-of-flight elastic recoil detection (ToF-ERD) analysis set up built by University of Jyvaskyla. ToF-ERD is a relatively new technique for material characterisation that is able to measure all the elements present in a sample. This enhances the current ion beam analysis capabilities at SIBC.

ToF-ERD involves an incident primary beam of ions entering a sample at a near glancing angle causing atoms to be forward recoiled out of the surface as shown in Figure 1. The recoiled atoms pass through two timing foils (T1 and T2), which enable their time of flight to be measured and then enter a gas ionisation chamber (GIC) through where their energies are measured. Elemental identification is now possible as atoms with the same energy but different mass can be separated by their different velocities unlike RBS and conventional ERD.

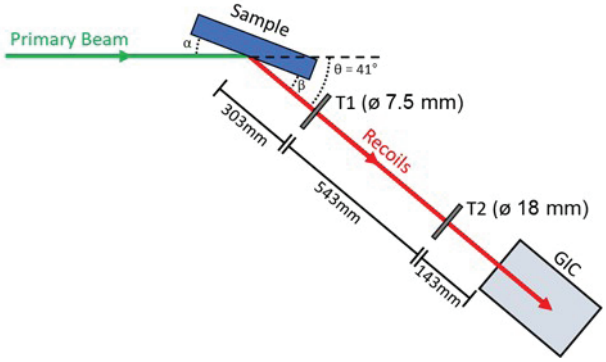

Figure 1: ToF-ERD set up at Surrey Ion Beam Centre @Univ. Surrey

Using the RADIATE transnational access enabled two visits for people from SIBC to travel to Jyvaskyla for 2 sets of ToF-ERD measurements on various samples, while our own system was being made. The first visit was in January 2020 and the latest visit happened in October 2021 and was also used as training on the system.

Our system arrived in March this year, with Mikko Laitinen and Jaakko Julin from Jyvaskyla visiting the first week of April to install and set up the system. The system has very good hydrogen detection efficiency of above 56% below 0.4MeV. Figure 2 shows an example ToF-ERD spectra for a TiO2 on Si sample taken using the new ToF-ERD setup.

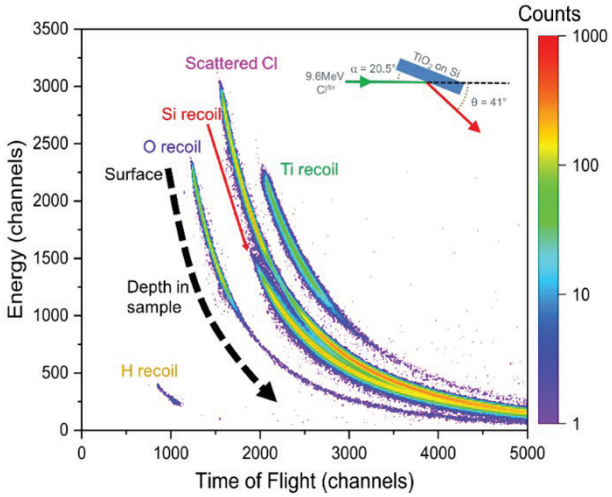

Figure 2: Example ToF-ERD histogram taken using ToF-ERD set up at SIBC. Using a 9.6MeV Cl6+ incident beam to measure a TiO2 on Si sample.@Univ. Surrey

The ToF-ERD has already shown to be not only a useful technique for surface analysis of light elements but also all elements within a sample especially when used in conjunction with RBS. Our system has already been used to measure a wide variety of samples from both academic and industrial collaborators, including Si and III-V semiconductor based materials, advanced semiconductor memories, battery materials, coated glass, polymers and even steel pipes.

RADIATE Personnel news

Hello! My name is **Johanna von Gerichten** and I recently joined Melanie Baileys' group at the University of Surrey as Research Fellow in Biological Mass Spectrometry and Multimodal Imaging. I did a BSc. in Chemical Biology and a MSc. in Biomedical Science and Technology at the University of Applied Sciences in Mannheim (Germany), before finalising my PhD in developing mass spectrometric methods for Lipids in biological tissues at the German Cancer Research Centre/University of Heidelberg. The last 3 years I worked in the Department of Nutritional Sciences at UoS where I tracked human metabolism through stable isotope techniques with MS.

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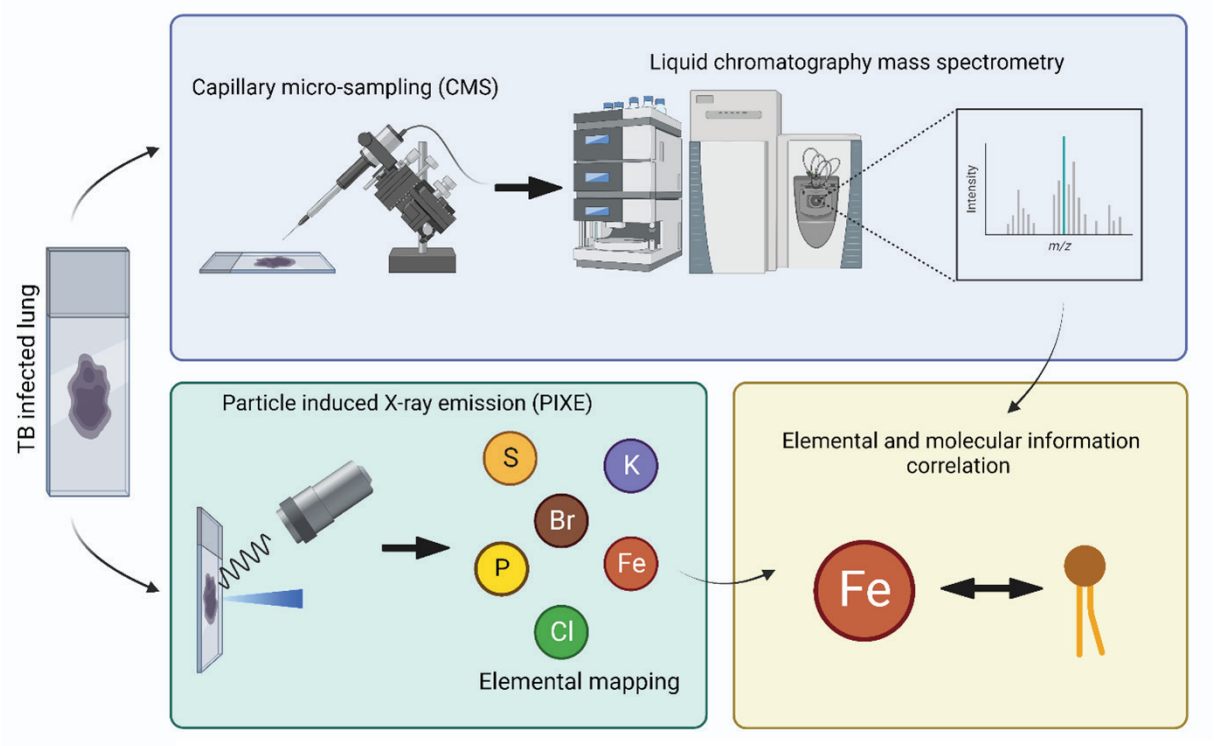
Co-location of lipids, drugs and metal biomarkers using spatially resolved lipidomics with elemental mapping

Holly May-Lewis, Catia Costa, Veronique Dartois, Firat Kaya, Mark Chambers, Janella de Jesus, Vladimir Palitsin and Melanie J. Bailey

In an article submitted to Analytical Chemistry, Lewis et al. describe the combination of spatially resolved molecular profiling using capillary micro-sampling with liquid chromatography mass spectrometry (CMS-LC-MS) and elemental imaging using particle induced X-ray emission (PIXE). The combination of these two techniques facilitated the localisation of elemental markers, lipid profiles and drugs in discrete areas of a tissue section and probe their relationship. The authors also demonstrated how drugs containing an elemental marker (in this case bromine (Br), present in bedaquiline) can be imaged using PIXE, and that CMS-LC-MS can provide a confirmatory analysis.

PIXE analysis was made possible through RADIATE transnational access.

Full text is available here:
https://doi.org/10.1021/acs.analchem.2c01940



Graphical abstract created by Matt Spick using BioRender @Univ. Surrey

New Publication

Nanoscale multiply charged focused ion beam platform for surface modification, implantation and analysis

New publication using data generated through RADIATE on “Nanoscale multiply charged focused ion beam platform for surface modification, implantation and analysis” by M. Lalande, P. Salou, A. Houel, C. Bourrin, A. Keiser, J-B. Mellier, A. Sineau, J-M. Ramillon, T. Been, A. Cassimi, A. Delobbe, S. Guillous.

DOI: https://doi.org/10.1063/5.0078914

Late Pleistocene glacial advances, equilibrium-line altitude changes and paleoclimate in the Jakupica Mts (North Macedonia)

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DOI: https://doi.org/10.1016/j.catena.2022.106383

Former extensive glaciation of the Balkan Peninsula – where currently only some rapidly shrinking small glacierettes survive - has been evidenced by the existence of glacial shaped valley and cirques, together with moraine ranges accumulated in front of the former glacier tongues. These glacial landforms enable the reconstruction of the former glaciers, which in turn can be used for glacio-climatological modelling of the climate conditions during their existence.

A crucial question is the timing of the glacial advances in order to provide the timeframe for the glacio-climatological investigations. The geochronological work in the Balkan Peninsula has already started, and a number of data has been published using U-series dating or exposure age determination using cosmogenic radionuclides 36Cl and 10Be. However, the results of these studies depict an ambiguous picture concerning the timing of the most extended glaciation.

To add novel data to the big puzzle of the regional glacial chronologies several sample sets were collected by our team in North Macedonia in the framework of the GeCosMa project (Geochronology of glacial landforms and cave sediments in Macedonia and implications for Quaternary landscape evolution in the Central Balkan Peninsula) funded by the National Research, Development and Innovation Office of Hungary (project no. 124807).

In the Jakupica Mts an ice-field was reconstructed (max. area ~45 km^2, max thickness: ~260 m), and a sample set was collected and processed for ^{10}Be exposure age dating. The RADIATE Transnational Access grant 19001688-ST provided the possibility of the Accelerator Mass spectrometry measurements of the ^{10}Be/^{9}Be ratios of our samples at VERA (Vienna Environmental Research Accelerator). The data were grouped and the most probable exposure age of the dated landforms was calculated using probability density functions. The ^{10}Be exposure age determination was successful for the moraines of the two phases of largest glacier extent: the local MIE to was dated at $19.3^{+1.7}/_{-1.3}$ ka, which was followed by a short phase of glacier recession and glacier stabilization at $18.2^{+1.0}/_{-3.0}$ ka (Fig. 1). These results are in agreement with other studies placing the maximum ice extent to the Last Glacial Maximum (LGM) in the Balkan Peninsula, while they are in apparent contradiction with others suggesting that it occurred during an earlier glacial phase.

Glacio-climatological modelling using the degree-day model was performed for the MIE, assigned to the LGM by the ^{10}Be exposure age data. Our model, constrained by the geomorphological evidence and by the July temperature drop suggested by pollen-based paleoclimate reconstructions, suggest at mean annual air temperature drop of 11±1 °C and points to slightly wetter conditions during the LGM with respect to present day values (30±10 % increase of mean annual precipitation) (Fig. 1). Our results indicating wetter (or similar to modern) conditions in the Jakupica Mts during the LGM and today are in agreement with paleoclimate models, which predict increased southerly moisture advection in the central Balkan Peninsula during the Pleistocene glaciations.

Based on the published paper: Ruszkiczay-Rüdiger, Zs., Temovski, M., Kern, Z., Madarász, B., Milevski, I., Lachner, J., & Steier, P. 2022. Late Pleistocene glacial advances, equilibrium-line altitude changes and paleoclimate in the Jakupica Mts (North Macedonia). CATENA, 216, 106383.

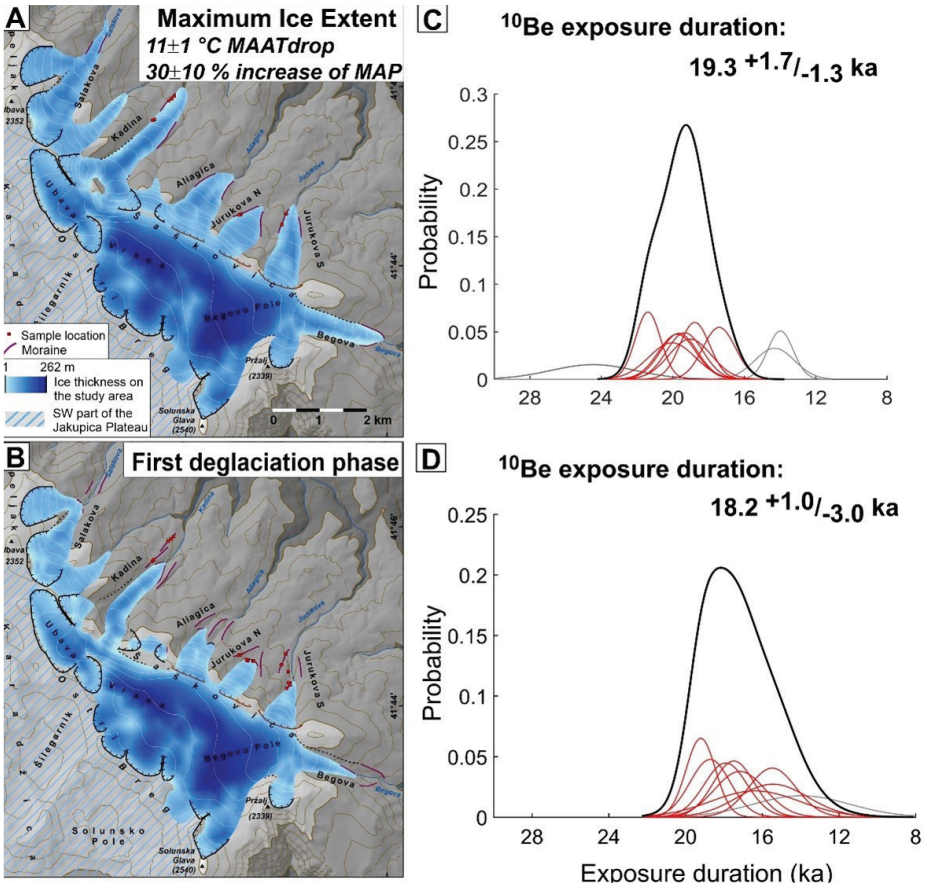


Fig. 1. Results of glacier reconstruction on the NE part of the Jakupica Mts the maximum ice extent (A), and second largest glacial phase (B) and probability density function (PDF) plots of the ^{10}Be exposure ages of these glacial phases (C), (D). Red and grey curves are the accepted and rejected data of the individual samples, respectively. The black lines are the PDFs of the accepted samples. MAAT: mean annual air temperature; MAP: mean annual precipitation; the values are reported relative to current data based on long-term meteorological observations.© Catena

Interview with Brian Jones, member of the User Selection Panel (USP)

Head of the accelerator facility at PARTREC (Particle Therapy Research Center)

What has your experience been like on the USP?

I have enjoyed the experience I've had thus far. Being on the USP has allowed me to be more included in the IBA community. In my new role as head of the accelerator facility at PARTREC I have been less involved, at least directly, with some of the IBA techniques I have used in the past. Being a member of the USP and reading these interesting proposals has offered me a way to keep closer to this field and I am happy that I can offer my experience to evaluate been a benefit and brought me closer.

What is the workload like on the USP?

It is manageable. I admit, though, that there are periods where I find that I am busy with other work-related tasks and then I get the reminder e-mails asking that I look at a proposal (or two). As I am managing a fairly large facility, very often it can be difficult to manage my time as evenly as I would like to complete my reviews within a short amount of time. In these busier times, it helps that I keep a separate calendar where I remind myself, sometimes over the weekend, to review find time to evaluate the proposals.

One thing I have noticed is that the proposals sometimes come in waves. What I mean is that I might go a month without having one to review, then I might get three in at once. This can make it difficult to plan my schedule accordingly.

Proposals are handled through RADIATE GATE, a single access point to submit proposals and the USP's main tool to review proposals. How has your work with GATE been like?

I find GATE fairly straightforward and user-friendly. I have recently even used the GATE website as an example when discussing the possibility of implementing modifications to a USP tool used in another project. I find it very useful that In RADIATE the facilities can see the result of the evaluation. This can be helpful when scheduling these experiments as the evaluation can act as a guide in prioritizing the distribution of beam hours that are allotted to each experiment.

Do you think COVID-19 caused a lack of proposals at specific times due to lockdowns?

This is difficult to quantify. The short answer is that I did not detect a lack of proposals at specific times due to lockdowns. I would guess that the real impact of the lockdowns and travel restrictions was to reduce the amount of travel so that the approved experiments could not be conducted at all during certain periods. I do not have those statistics.

What is the most interesting RADIATE proposal to come your way?

I find all of the proposals to be interesting. For me, this RADIATE proposal, which was very well written, I think gives a good indication of what RADIATE can offer through the application of IBA:

The role of intracellular prosthesis debris in early hip joint failure

„Debris of hip joint prostheses are suspected to cause early failure of implants. In this study it is intended to investigate this rare type of failure in a patient where most alternative causes can be excluded. Numerous infracellular particles were detected by routine histopathology in surrounding tissue but determination of the particle composition was not possible. PIXE is a technique sensitive enough to identify the material causing the adverse reaction developed by the patient. It is the aim of the project to look for the lateral distribution of Zr and Ti in three tissue samples that can prove the origin and the exact location of the debris. This will help to better understand this kind of undesirable failure of implants."

Have you noticed anything about the diversity of the proposals?

The quality has been quite high. I'm also involved with another project, RADNEXT, where my facility is providing transnational access for radiation hardness tests. This project also has a USP and a process of evaluating proposals. We're in the first year and the rejection rate was quite high.

Sometimes somebody will apply that they want so many hours of beam time to perform a specific experiment and I can see that it's important and that it will probably work out and be publishable, but it's not explained in the proposal. It's for me to interpret. It's as if someone came to them and said "hey, you should do this, you should use this technique", but when they wrote the proposal they didn't have the basis and didn't know why they were asking for it scientifically. And I'm struggling a little bit with this, and am hoping to discuss this with the other USP members to see how they handle it and that we can come to an agreement.

© B. Jones

Any tips for proposal writers?

Always state your motivation and justification for using a particular technique clearly. And do it in more than one or two sentences. Do not leave me to fill in too many blanks. If, for example, you are asking for 40 hours or more of beam time and you have hundreds of samples to analyze you should treat me as someone who has never used these techniques before in convincing me that the technique and amount of time is justified.

What do you look for in a good proposal?

If I think it will bring publishable results, especially in a high impact journal. This is usually clear if the proposal is well-written and thought through beforehand. Societal benefit can also be an indicator of a good proposal. I can overlook a poorly written proposal if I can clearly see that the results from an experiment will have a positive impact on some societal challenge.

Would you like to briefly tell us what your own facility, PARTREC, is doing?

Absolutely. PARTREC is part of the University Medical Center Groningen, Netherlands. We provide beam from our large superconducting cyclotron, delivering beams of up to 190 MeV protons, 90 MeV per amu for ions of helium to oxygen, 30 MeV per amu heavy ion cocktail of up to Xe. We have customers in the field of radiobiology, radiotherapy, (medical) research, as well as radiation hardness testing. We offer beam time through transnational access in EU-funded projects, such as RADNEXT and INSPIRE. We also sell our beam hours commercially, in which case a proposal is not necessary. All beam requests can be sent to: irradiations.partrec@umcg.nl

Interview with Johan Meerrsschaut, RADIATE industry partner

Senior Researcher at imec

The Joint Research Activities are now slowly coming to an end and the industry partners have fulfilled most of their responsibilities. How do you look back at RADIATE?

We benefited a lot from RADIATE. This project gave me some leverage to reserve more resources internally and thanks to this project we have been able to set up a new accelerator, a Van-de Graaff, at imec. We aim to do high resolution RBS with a magnetic spectrometer and thanks to the RADIATE funding we were able to defend the accelerator project internally.

I also appreciated very much the collaboration that we had, we had very intense collaborations with Surrey. We did a project that otherwise would not have happened. Imec used the microbeam at SURREY, we complementary studied it also with ensemble measurements in KU Leuven. By doing the comparison, we could much better understand the benefits and limitations of the two approaches.

How did the COVID pandemic affect your work?

For us personally we were not very much affected by Corona internally. Our company dealt very well with keeping the lab work as active as possible. We had very few interruptions imposed by federal government. Corona did affect the way we could easily go for experiments abroad. Our PhD student was supposed to have two experiments abroad, but this had to be done off-hands with video conference calling. We managed to achieve everything due to the great support from Surrey, but it would have been a good working experience for the PhD student to go for the beam time himself.

Did you achieve what you set out to do?

Yes, we did. We reached all of our deliverables. We are hoping for a follow-up project, as there are still many things to be done.

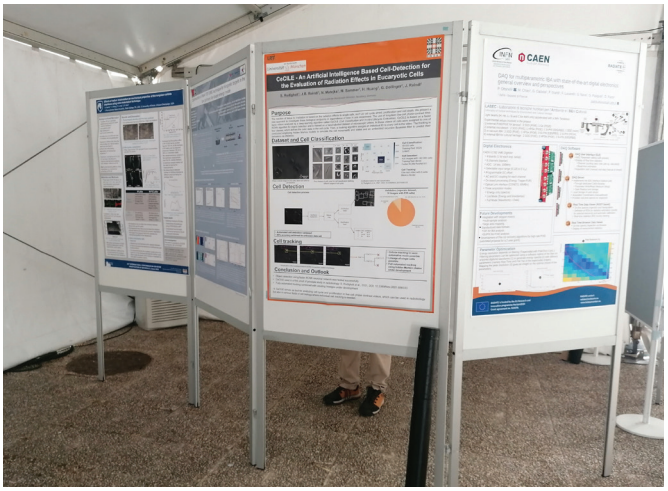
Do you have any suggestions for improvement or change?

If there was a new project, I would like to see the addition of more technical peer-to-peer support - to give mutual help and feedback to operate accelerators. Currently, every lab is figuring out problems by themselves and more interaction would be very helpful.

Transnational access gave us the ability to easily do experiments in other labs, which was a huge chance. Cross-lab work should also be possible, it does not always have to be transnational. The idea that every single lab should do every single method seems a bit old-fashioned to me.

The good thing is that we made new connections through RADIATE that grew stronger as the project progressed. For the foreseeable future, these connections will last, but the new generations of scientists needs projects like RADIATE to establish their networks. Senior scientists have their networks. It is easy for them to contact other labs and people and they will receive a reply to their requests. It is much harder for early career researchers.

Impressions from the Joint Research Activities Poster Session

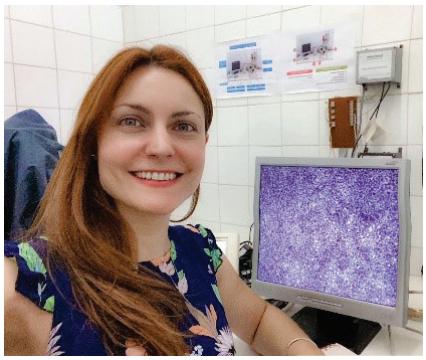


The calm before the storm - some of the JRA posters ready to be viewed by the consortium © A. Berens

The poster session in full swing © A. Berens

Interview with Eliana Bianucci, Transnational Access User

Researcher at the Institute of Agrobiotechnological Research (INIAB-CONICET)- FCEFQyN – National University of Río Cuarto, Río Cuarto, Córdoba, Argentina.



© E. Bianucci

Would you like to briefly introduce yourself and your research to our readers?

I'm from Argentina and I'm currently doing an internship in the Departament of Animal Biology, Vegetal and Ecology, Autonomus University of Barcelona, Barcelona, España. My project is about the effects of arsenic in peanut plants and in the interactions that peanuts have with associated microorganisms. Peanuts are a very valuable crop in Argentina and different environmental stresses on this plant are studied, like flooding, drought, or heavy metals. I research all the effects different kinds of arsenic contamination has on peanuts, but in this internship the work was focused on the impact of arsenic on peanut plants aggravated by flooding episodes.

How did you find out about RADIATE?

My intention was to analyze As distribution and location (also other different important elements) in different peanut tissues in plants subjected to As, flooding (F), and the combined treatment (As and F). However, I didn't know how or where to do this. My supervisor in Barcelona, Dr. Charlotte Poschenrieder, told me about RADIATE and we got in touch with one of the facility managers in Slovenia, Paula Pongrac, and wrote a proposal.

I wanted to analyze the localization and concentration of arsenic in roots, leaves, and peanut nodules. This is the first time micro PIXE was used in these kind of plants. We didn't know what we were going to find, if we were even going to obtain results. We did and they were really interesting.

So what's the verdict?

Arsenic could be located in different peanut tissues and its accumulation is definitely something to take into consideration.

Why is Argentina so badly affected?

Arsenic occurs naturally and its main source is groundwater. Although As constitutes a global problem, in Argentina, for example, this metalloid has gained a special interest due to human contamination. Especially in Córdoba province, the groundwater contains As concentration that exceeds the allowed limit for human consumption (FAO). Many people drinking the water in the region developed health problems, a pathology named HACRE (chronic regional endemic hydroarsenicism), that induced several cancer types. Furthermore, the ingestion of contaminated food is currently getting much attention and here is where we focused our work with peanut. This groundnut is considered the 13th most important food crop in the world and Argentina is one of the top peanut exporting countries followed by India and the USA. Approximately 90% of the Argentinean production of peanut is located in Córdoba province, where 90% of the groundwater of the region is affected by As presence. The problem arises as crops can incorporate the metalloid by direct absorption of groundwater or by artificial irrigation. Moreover, in the past years, the occurrence of flooding episodes has aggravated the situation since groundwater could easily reach rhizosphere level, the area of the soil where plant roots still can reach. This issue constitutes not only an agronomic problem, due to the effect in grain quality and yield, but also a serious risk for human health.

Is arsenic a problem in all plants?

Yes, it is a problem for all plants subjected to this kinds of stress. I also studied this issue on soybeans and corn, for example. It is really interesting because, on the same field, some plants might be in a deep slope and subjected to groundwater levels, while a few meters away another plant is not. So on the same field you might have some highly affected plants and some that are not affected at all. It is a very localized problem, but due to Argentina being one of the top ten peanut exporter, this was an important issue that needed to be studied to avoid human contamination. We, thus, were interested in finding out if and what the impact of this arsenic groundwater has on crops.

We are also trying to find strategies to avoid the translocation or arsenic from the roots to the leaves and, most important, to the grain. This is the main topic of our study because we will not be able to remove the metalloid from the groundwater, so we need to analyze biological strategies like the use of microorganisms to keep the arsenic in the roots and avoid translocation.

How has COVID impacted your research?

I couldn't go to the lab in Slovenia for my transnational access. My proposal was accepted at the end of 2019 and then the pandemic hit. I got in contact with Paula Pongrac, she and her colleagues, were the ones that made all the analysis for us. We did a lot of zoom calls and Paula showed me everything and explained how the technique works and send me the results. It doesn't replace the hands-on experience, though, and I would like to go and see and learn how it all works.

How was the process of applying to transnational access for you?

It was easy to apply, we wrote the proposal and formulated what we wanted to address. Paula helped me write the technical aspects of it. The whole application process and also submitting the report after the beam time was straight forward.

Are there any outcomes from your transnational access experiment?

Yes, we presented our results at different conferences and made the technique better known in the community. We are also currently preparing two papers. Then, we also want to analyze the grain of peanut plants; we didn't have time to do this, yet. The next step would be to analyze the arsenic in the microorganisms that establish a symbiotic interaction with peanuts since, depending on the strain, they modulate As translocation in peanut plants. Therefore, it will be really interesting to analyze how these little peanut friends respond to As by using micro-PIXE.

I´m very grateful to RADIATE for the opportunity to perform this work and I hope to obtain more interesting results with their valuable ion beam facilities.

Deciphering the localization and concentration of arsenic in nodules of peanut plants affected by combined metalloid and flooding stress

Bianucci Eliana[1,2], Paula Pongreac[3,4], Katarina Hrovat[3], Katarina Vogel-Mikuš[3,4], Primož Pelicon[4], Mitja Kelemen[4], Primož Vavpetič[4], Ana Furlan[1], Charlotte Poschenrieder[2]

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Natural combined stresses are challenging the sustainability of agro-ecosystems affecting significantly crops every year. Arsenic (As) presence in groundwater represents a global problem due to human contamination and the occurrence of flooding aggravates the situation. In Argentina, several cropping areas are affected by flooding episodes, which increase As-containing groundwater level. When reaching the rhizosphere, As is easily absorbed by plants and this uptake constitutes the first step of tropic chain contamination. Peanut (Arachis hypogaea L.) is an economically important legume crop. In Argentna its production is mainly located in Córdoba province, where 90% of the groundwater contains high As levels and flooding episodes are frequent. This legume engages in a symbiotic interaction with Bradyrhizobium sp. members that improves plant nitrogen (N) supply by the biological N fixation with the formation of a new organ in the root, the nodule. A large amount of elements is needed to assure this process functions, for example nitrogenase enzyme complex is iron (Fe) and molybdenum-dependent. Several abiotic stresses, such as As and flooding, affect nutrient uptake by plant roots and this could lead to an alteration of essential element distribution within the nodule. Thus, to analyze element disturbances on peanut nodules, plants inoculated with Bradyrhizobium sp. SEMIA6144 were exposed to As, flooding and the combined stress. Using X-ray fluorescence, we could determine, the concentration of As and also phosphorus (P), sulphur (S), chlorine (Cl), potassium (K), calcium (Ca), Fe and zinc (Zn); and using quantitative micro-particle induced X-ray emission we could locate the mentioned elements at tissue level. Resolving the localization and distribution of As and other essential elements in peanut nodules, will significantly contribute to the knowledge of the disturbances caused by these stresses in peanut crop. These results may also contribute to finding novel strategies to avoid crop contamination by toxic elements.

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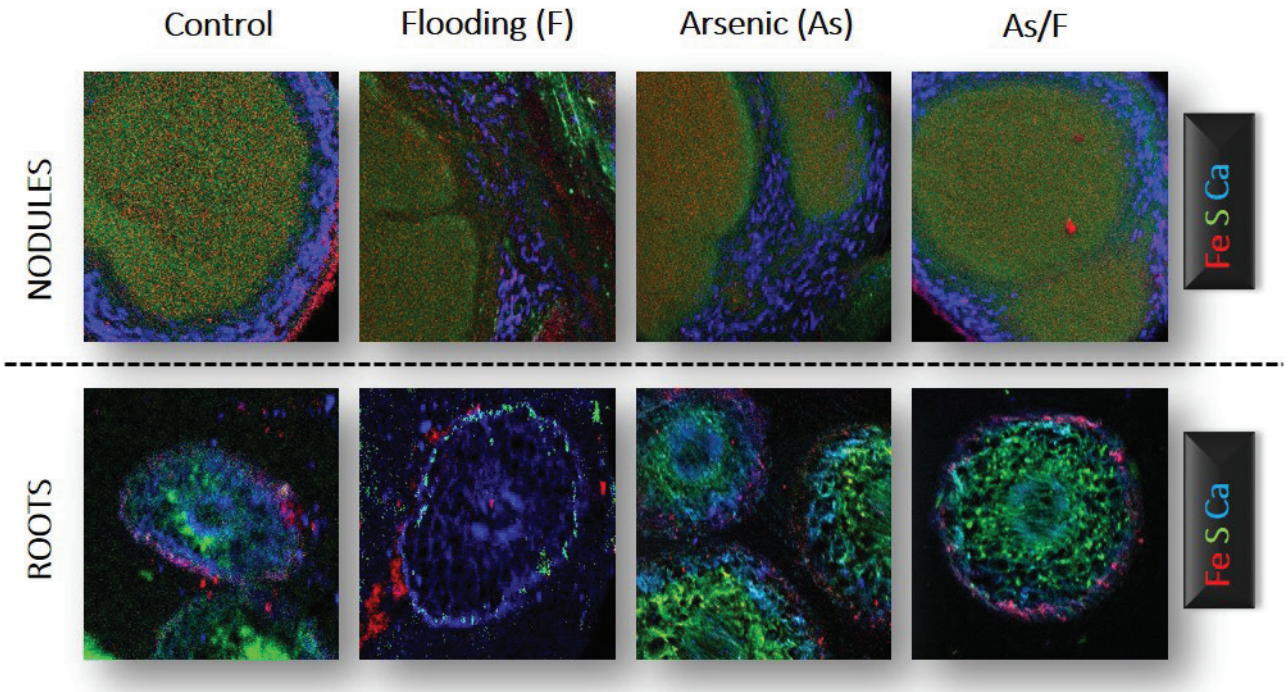

Interview with Roman Garba, Transnational Access User

Researcher at The Czech Academy of Sciences

Can you tell us a little bit about yourself?

I'm affiliated with two institutes at the Czech Academy of Sciences – the Nuclear Physics Institute and the Archaeological Institute Prague. I know it sounds like the two fields have not much in common, but the radiometric dating methods using AMS are connecting the two. The most known is radiocarbon dating method widely used in archaeology. My focus is on applications of cosmogenic nuclides ^{10}Be and ^{26}Al in archaeological context. This method is still rarely used in archaeology and mainly performed by labs from the USA and Australia.

How did you find out about the RADIATE project?

I heard about it from Stephanie Neuhuber, she is working at BOKU (Institute of Applied Geology (IAG) at the University of Natural Resources and Life Sciences, Vienna) and she is doing cosmogenic nuclide sample preparation in cooperation with VERA. We have a joint project in Oman and she suggested applying for RADIATE as she was already involved with other RADIATE proposals. This suggestion turned out to be very useful, and I am glad for it.

And you first did the twinning program? [Editors' note: we reported on Roman's twinning stay in newsletter number #2, February 2020]

Yes, I did the twinning. I found out about the RADIATE project, looked at the website, found out about twinning opportunities, and thought it was a good idea. I applied. Three years ago, I knew I needed to get more experience and AMS knowledge with my background covering just engineering and archaeology. The twinning stay at VERA was very useful, they have an exciting AMS facility with green laser isobar suppression and other instrumentation advancements.

How was the process going from the twinning stay to your own transnational access proposal?

Twinning gave me an overview and got me familiar with the process. TA was the logical next step to apply cosmogenic nuclide dating for archaeology use cases. We submitted several proposals; this one is the most successful yet. One sadly had high sample impurities, so the samples were challenging during quartz purification process and not suitable for AMS measurements. Another one was postponed because of COVID, among other things. We are starting sample processing now, though. We will be able to send them to ETH Zurich later this year.

You were invited to the RADIATE midterm meeting as a TA user – can you tell us about your project?

It is a nice example of how ion beam physics can try to answer some key questions related to human evolution such as when the first people arrived in Central Europe. We assume that the early humans - hominins - migrated from Africa in the first wave as Homo Erectus. When this happened is known from Southern Europe, where stone tools and fossil bones have been found and stratigraphically dated to be more than million years old. But we still are not sure when this happened in Central Europe, as we are completely missing robustly dated Early to Middle Pleistocene archaeological sites in this region. Possible hominin dispersal routes are still under extensive debate with several hypotheses. By using cosmogenic nuclides ^{10}Be/^{26}Al, the project aims to determine the age of the oldest cultural layer surrounding stone tools found in Korolevo, Transcarpathia, Western Ukraine. Previous chronological assumptions were based on paleomagnetic studies, thermoluminescence, and OSL (optically stimulated luminescence) dating. But the age of the oldest level remains problematic.

Stone tool from Korolevo I. site © R. Garba

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We also used the RADIATE guest researcher program and my colleague, Jan Kamenik ,performed sample purification and Be/Al separation under the supervision of Konstanze Stübner at HZDR. The AMS measurements, as TA project, was also done at HZDR with the support of Johannes Lachner, Georg Rugel and the DREAMS team. The preliminary result of AMS analysis is promising. Currently, we are at the critical stage and team headed by John Jansen from the Geophysical Institute of the Czech Academy of Sciences is applying state-of-the-art Markov chain-Monte Carlo-based inversion method known as P-PINI (Particle Pathway Inversion of Nuclide Inventories) to calculate the absolute burial age. The method was published in 2020 and we are the first ones to use it in an archaeological context.

This project is a good example for dissemination, as the wide public can understand the research results. It is also an example of collaboration of multiple teams from different fields such as archaeology, chemistry, ion beam physics and geology. It was possible to put together a "dream team" of the best experts in multiple disciplines working on one multi-disciplinary project.

Why did you choose Central Europe and Western Ukraine specifically?

I knew the method and its limitations such as expected burial age and preferable sample buried depth. The archaeological site Korolevo in andesite quarry showed to be a

perfect candidate as it supposed to be older than 780 ka and with accumulated 14m of loess paleosol profile. By luck I knew Vitaly Usik, a Ukrainian archaeologist working in Korolevo since many years.

What will come after the TA?

The beam time we received through transnational access was for the AMS measurements. After necessary calculations, we reached the number of atoms per gram for ^{10}Be and ^{26}Al. Now, a team of geologists is performing the burial age calculation using mathematical models, and later, archaeologists can interpret the results in archaeological and anthropological context. We submitted a manuscript to the Journal of Radioanalytical and Nuclear Chemistry, discussing physical and chemical sample preparation and purity control via ad-hoc mass scans at HZDR. The article with isochron burial age result will follow when the calculation will be finalized.

How was your overall experience with RADIATE?

RADIATE was the key enabler to make this project happen and successful. Firstly, because of the beam time access. We didn't have AMS in the Czech Republic back then. Now we do, we are extending our chemical treatment labs and putting our multi-isotope 300 kV AMS MILEA into routine operation with support of IonPlus AG, ETH Zurich and others. Secondly, the knowledge transfer was crucial and HZDR team was very supportive. Our institute used all options available in RADIATE – the twinning program, transnational access, and the guest researcher program. In Prague we had experience with ^{14}C sample preparation and other radioanalytical methods such as INAA. Without the RADIATE programs it would have been difficult to do this project in such a short time.

Andesite quarry of Korolevo I. archaeological site with loess paleosol profile rich in lithic artefacts
© R. Garba

TCN Burial Dating of the lower palaeolithic horizon at the Korolevo site in Transcarpathia, Western Ukraine

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Keywords:
Beryllium-10, Aluminium-26, Human Evolution, Hominin, Accelerator Mass Spectrometry, Ukraine

Abstract
The Korolevo I. in Transcarpathia (western Ukraine) is a key archaeological site of Lower Palaeolithic hominin occupation, thought to be the earliest in Central and Eastern Europe. The chronology of the site, however, remains problematic and disputed. The assay of in-situ terrestrial cosmogenic nuclides (TCN) ^{10}Be and ^{26}Al is central in determining the age of the oldest cultural layer VII. The cobbles from disputed layer excavated in the 1980s and pebbles of modern Tisza riverbed were selected for processing. Sample crushing, magnetic separation, quartz purification and Be and Al extraction were conducted following standard methods, Be and Al isotope ratios were measured on the DREAMS accelerator mass spectrometer (Helmholz-Zentrum Dresden-Rossendorf). The samples exhibited various levels of weathering, lithology, and mass. To examine potential effects of heterogeneous sample composition or incomplete chemistry on the determination of ^{10}Be and ^{26}Al abundances, ad-hoc mass spectrometry scans were performed following the AMS measurement. For the burial age determination, we will apply a Markov chain-Monte Carlo-based inversion method known as P-PINI (Particle Pathway Inversion of Nuclide Inventories). Our results will contribute to a better understanding of one of the earliest hominin settlements in Europe.

Conference Report

IBMM - 22nd international conference on ion beam modification of materials

IBMM took place in Lisbon, Portugal between the 11th and 15th of July 2022 (http://www.ctn.tecnico.ulisboa.pt/IBMM-2022/index.html).
The conference, chaired by Katharina Lorenz, Eduardo Alves touched on topics such as Basic Mechanisms and Irradiation Effects, Defect Engineering, Nano-science and Technology, Ion Beam Processing of Materials, Ion-Driven Selforganization, New Accelerator Systems and Single Ion Implantation. Speakers and presenters were given a chance to present their ground breaking research in this field and exchange ideas with other experts in the field. Overall, 165 participants from 32 countries and 5 contintents gathered to attend the talks. A large number of participants came from Portugal, Germany, France, USA, England, and Poland. The programme included 1 plenary talk, 12 invited talks, 46 oral contributions and 106 poster presentations divided in 2 sessions. During the conference the best young oral and poster presentations were awarded. The IBMM Prize was awarded to Matheus Tunes from Los Alamos National Laboratory by the Secretary of the IBMM international Committee, Robert Elliman.

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Dissemination

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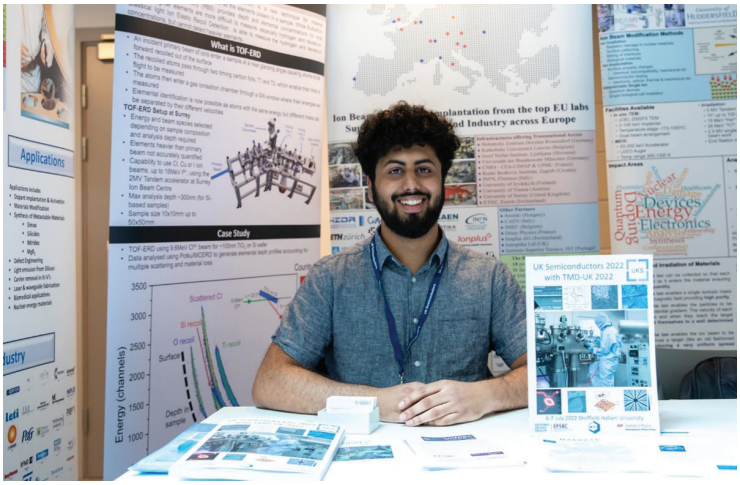
RADIATE at The European Physical Society (EPS) Forum, held on 2-4 June is Paris, France



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RADIATE at the UK Semiconductors 2022 Conference, held on 6-7 July is Sheffield, UK

Upcoming conferences

October

30 October – 2 November - **26th Conference on the Application of Accelerators in Research and Industry (CAARI) & 53rd Symposium of North Eastern Accelerator Personnel (SNEAP)**, Denton, Texas - https://www.caari.com

November

6-10 November – **10th International Workshop on High-Resolution Depth Profiling (HRDP-10)**, Adelaide, Australia - https://www.flinders.edu.au/institute-nanoscale-science-technology/high-resolution-depth-profiling-conference

6-11 November, **AVS68**, focus topic on Advanced Ion Microscopy & Ion Beam Nano-Engineering, Pittsburgh, PA, USA. https://avs68.avs.org/focus-topic-hi/

27 November – 2 December - **Materials Research Society Fall Meeting**, Boston, Massachusetts, USA - https://www.mrs.org/meetings-events/fall-meetings-exhibits/2022-mrs-fall-meeting-exhibit

2023

31 January to 5 February 2023 - **ARCEBS-2023, 5th International Conference on Application of RadiotraCers and Energetic Beams in Sciences**, Purulia, India, https://indico.cern.ch/event/1155596/

7-12 May 2023 - **IPAC2023**, Venice, Italy, https://www.ipac23.org/

30 May - 2 June - **EIPBN 2023**, San Francisco, CA, USA, https://eipbn.org/

26-30 June, ***ICMAT2023***, Singapore, https://icmat2023.mrs.org.sg/

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