Issue # 8 - April 2023

Newsletter

So long, farewell!

It has been four years since we started this adventure! I was a bit lost for what to write in this last newsletter so I asked ChatGPT to help out – I think it put it beautifully!

Dear RADIATE Community,

It is with bittersweet emotions that we write this farewell newsletter introduction for the RADIATE project. After 4 years of running, we have seen the incredible work and dedication of our research partners and SMEs as they joined forces to structure the European Research Area of ion technology application.

Through the exchange of experiences and best practices, RADIATE has made significant strides in further developing ion beam technology and strengthening the cooperation between European ion beam infrastructures. We are proud to have provided easy, flexible, and efficient access to our participating ion beam facilities for researchers from academia and industry.

As we close this chapter in the RADIATE project, we want to emphasize the tremendous impact that has been made over the past 4 years. We have facilitated groundbreaking research and innovation, paving the way for new discoveries and advancements in the field of ion technology application. Through the project, we have been able to provide transnational access to users who successfully underwent the RADIATE proposal procedure.

We want to extend our sincere gratitude to everyone involved for their hard work and dedication to making this project a success. It has been an honor to be a part of such an important initiative, and we are proud of the accomplishments we have achieved together.

As we bid farewell to the RADIATE project, we look forward to seeing the continued impact of the work done through RADIATE in the years to come. We are confident that the legacy of the project will continue to inspire future generations of researchers and innovators. Thank you all for your support and commitment to the project over the past 4 years.

Best regards,
The RADIATE Project Team

In this edition read about:

RADIATE Contact

www.ionbeamcenters.eu

NEWSLETTER EDITORIAL

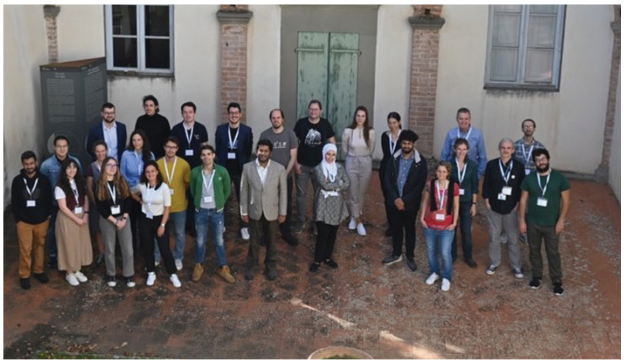
Catia Costa
University of Surrey

@ionbeamcenters

RADIATE is funded by the EU Research and Innovation programme Horizon2020 under grant agreement no. 824096

RADIATE Summer School 2022
INFN in Florence, Italy, from 5-7 October 2022

By Massimo Chiari



A group photo of the RADIATE Summer School 2022 participants in the courtyard of Villa Il Gioiello © RADIATE

The last RADIATE Summer School was held in Florence, Italy at Villa Il Gioiello ("The Jewel"), a Renaissance villa owned by the University of Florence, set on the southern hills around Florence, where Galileo Galilei spent the last years of his life, and at the LABEC ion beam laboratory. Although the school was organized in presence, thanks to the improved pandemic situation, it was decided to opt for a hybrid meeting format to increase the audience of potential participants.

The focus of this RADIATE Summer School was on environmental applications of Ion Beam Analysis and Accelerator Mass Spectrometry. The first two days of lectures started with an introductory lecture on the basis of IBA or AMS, followed by lectures focusing on applications of these ion beam techniques to environmental studies, such as plant biology, climate change, air pollution and atmospheric aerosols issues, geology and oceanography.

Each day after the final lecture, the participants made short presentations of their own work or research projects. This exercise was well respected by the participants and appreciated not only by the participants, but also by the lecturers. It resulted also a strong networking driver for the establishment of links between the early stage researchers.

The third day was devoted to a laboratory visit to the LABEC ion beam laboratory of INFN in Sesto Fiorentino, near Florence, where not only the accelerator and the beamlines were described, but also ancillary facilities such as the AMS sample preparation laboratory or the aerosol laboratories (where aerosol samplers are designed and maintained, or where measurements of aerosol carbonaceous components are carried out) were visited.

The Thursday evening Summer School dinner was organized at Omero traditional Florentine restaurant, just in front of the Villa; the cosy atmosphere and the typical Florentine meal, inclusive also for those having different dietary requirements, were very much appreciated by the Summer School participants. Before moving to the restaurant there was time for a tour inside the Villa, exploring all the rooms where Galileo lived assisted by his disciples, as the scientist Evangelista Torricelli, and studied (here he finished the "Dialogue Concerning the Two Chief World Systems"), and the vineyard where Galileo personally cultivated the vegetable garden and the vines.

A picture of the participants during the visit to the LABEC ion beam laboratory of the INFN in Sesto Fiorentino, Florence, Italy, while Massimo Chiari is explaining the set-up at one the external beamline. © RADIATE

The Summer School was attended by 34 participants from 16 countries. The circumstances that the school was organized as hybrid meeting and free of charge, and thus easily accessible, probably helped us to attract also 21 participants from outside the RADIATE project.

Artificial neural networks to support high-volume Rutherford backscattering analysis of patterned samples at the nanometer scale

Niels Claessens*[1,2], Annelies Delabie[1,3], André Vantomme[2], Wilfried Vandervorst[1,2], and Johan Meersschaut[1]
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Ion beam analysis is expected to remain a cornerstone of advanced materials characterization to further support the R&D activities at imec. To provide this service we operate a 2MV NEC tandem accelerator equipped with Rutherford backscattering spectrometry (RBS) and ToF-E heavy ion elastic recoil detection analysis end-stations [1]. Yet, recent advancements in the field of semiconductor technology pose the need for nanometer scale analysis on patterned samples. A disruptive method to achieve this for Rutherford backscattering spectrometry, without focusing of the ion beam, is the ensemble measurement concept [2, 3]. In this concept many identical nanostructures are measured simultaneously which leads to an excellent sensitivity and short data acquisition time. However, the data analysis for RBS spectra obtained on nano-patterned samples is much more complex than in the case of blanket films. To reach to a routine analysis of nano-patterned samples the data-analysis bottleneck must be resolved.

In many fields of science and technology deep learning technologies have been successfully applied to automate complex processes, in some cases even showing beyond-human capabilities. This fact has not gone unnoticed to the ion beam analysis community as is reflected by the growing number of publications reporting the application of artificial neural networks in the field. Artificial neural networks are a set of algorithms which can efficiently learn the relation between different parameters from large data sets of labelled data. Examples include recognizing objects in images, perceiving semantics from text, and extracting sample parameters from measured spectral data. The attractiveness of artificial neural networks for data analysis applications is that if the network can be trained to perform the analysis, the analysis after training is nearly instant. Furthermore, in the case of Rutherford backscattering spectrometry the data set for training the network (training set) does not need to be made by hand and can be automatically generated using the available simulators.

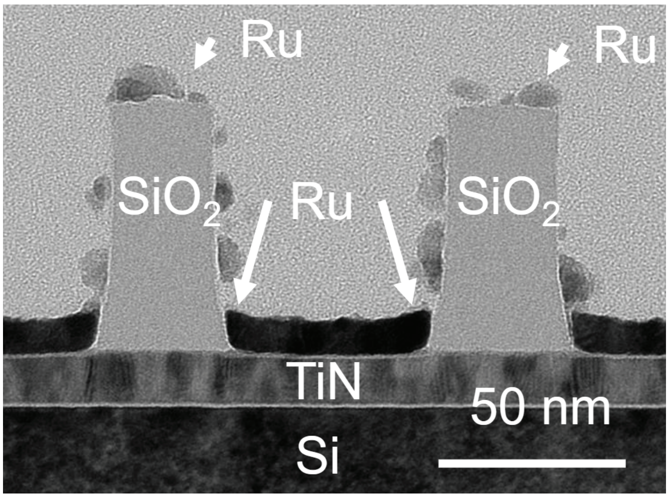


Figure 1: Transmission electron microscopy image of one of the nanopatterns. © imec

Given these insights, an artificial neural network was trained to perform the data analysis reported in reference [3]. In the referred work, information from transmission electron microscopy (TEM) images and Rutherford backscattering spectra at normal and grazing exit angle were combined to quantify the local areal densities of Ru on the different sites of nanoscale line patterns down to 10^{13} atoms/cm^2. Figure 1 displays a transmission electron microscopy image of one of the samples which shows Ru being present on the various surfaces: on top of the lines, at the sides, and at the bottom covering the TiN.

The artificial neural network was designed to accept data from both the transmission electron microscopy images as well as the Rutherford backscattering spectra as inputs. To enable this, the following preprocessing steps were performed.
First, the transmission electron microscopy images were analyzed to determine the sizes of the spatial features of the structures. Second, the Rutherford backscattering spectrum at normal exit angle was used to determine the total areal densities of the materials on the wafer. Finally, the sizes from TEM, the areal densities from RBS, and the grazing angle Rutherford backscattering spectrum together form the input for the network. A training set was generated by drawing the sizes and areal densities randomly from the relevant part of parameter space. For each example the grazing angle spectrum was simulated and combined with the other input data to train the network.

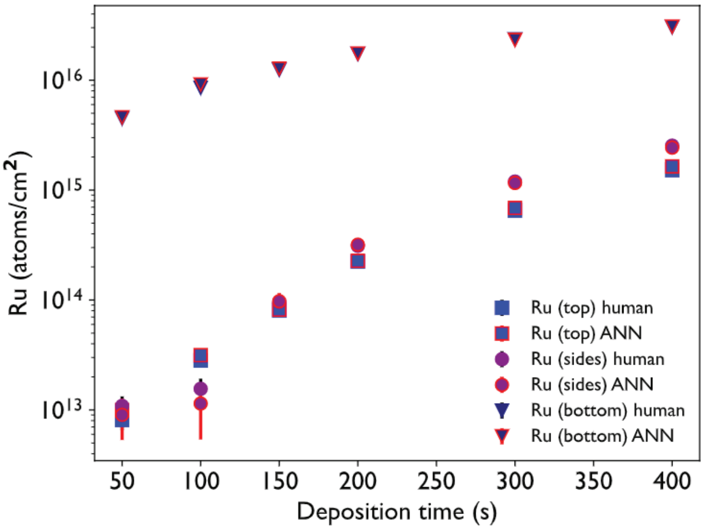


Figure 2: Areal density of Ru at the top, on the sidewall and on the bottom of the lines, as a function of deposition time as quantified by the artificial neural network (ANN) and a human analyst. Notice that the areal densities are not rescaled as is done in reference [3]. © imec

After training, the network was evaluated on the experimental data presented in reference [3] and its output was compared to the human data analysis, the result of which is shown in figure 2. As can be seen in the figure both approaches are in good agreement. The estimated uncertainty for the artificial neural network and for the human data analysis is found to be very similar when the areal density is larger than 1014 atoms/cm2 but differences are noticeable for areal densities below this value. It is still a subject of investigation if this originates from the artificial neural network having a poorer performance, or from an underestimation of the uncertainty for the human data analysis. Yet, with the present case study, we demonstrate that artificial neural network can support the ion beam analysis community to study complex nanostructures and support the advanced data analysis.

In conclusion, our work illustrates that high-volume analysis and sample complexity do not need to be mutually exclusive. In the presented case the data analysis bottleneck is resolved by training an artificial neural network to perform the data analysis. Furthermore, the network is shown to have a near human performance. In our future work, we envision to enhance the methodology by recording multiple independent Rutherford backscattering spectra to further confine the regression problem.

[1] J. Meersschaut and W. Vandervorst, Nuclear Instruments and Methods in Physics Research B 406 (2017) 25–29.
[2] G. Laricchiuta, W. Vandervorst, I. Vickridge, M. Mayer, and J. Meersschaut, Journal of Vacuum Science & Technology A 37 (2019) 020601.
[3] N. Claessens et al, Scientific Reports 12 (2022) 17770.

Chemical Imaging of Organic Materials by MeV SIMS Using a Continuous Collimated Ion Beam

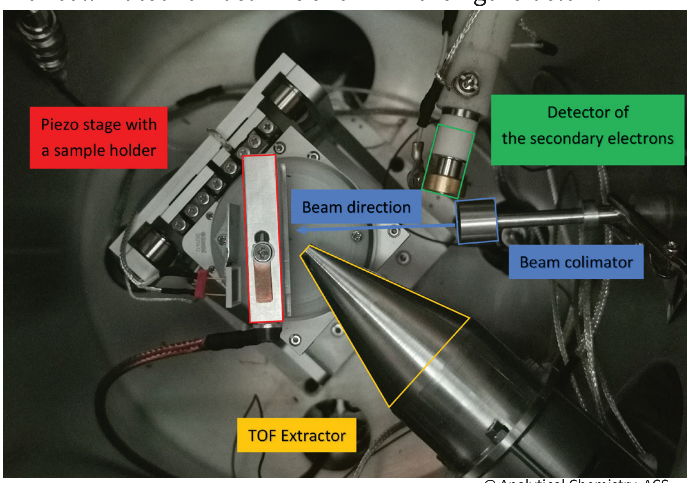
Zdravko Siketić, Iva Bogdanović Radović, Marko Barac, Marko Brajković, and Marijana Popović Hadžija

In the recent article published in Analytical Chemistry (https://doi.org/10.1021/acs.analchem.2c05234), a group from Ruđer Bošković Institute presented a new MeV SIMS setup for chemical imaging of organic materials using a continuous collimated ion beam. It is an improvement of the MeV SIMS imaging setup that was based on collimation of the ion beam through a conical glass capillary and published in JASMS in 2021 (https://doi.org/10.1021/jasms.1c00200). Regardless the good results of MeV SIMS imaging with a beam collimated through a glass capillary, two problems were noted:

1. Nearly 50% of the beam ends in a beam halo, resulting in blurring of the 2D chemical images.

2. The START signal for the TOF measurement is generated by the secondary electrons emitted from the sample surface, which can be problematic for samples with low secondary electron emission.

The solution was to perform the collimation of the ion beam through an ordinary microscope aperture (~10 µm hole) instead of using a conical glass capillary. In addition, a thin carbon foil (~ 5 nm) was placed over the aperture to create secondary electrons generated by the passage of primary ions so that the START signal for TOF is independent of the type and composition of the sample under study. Imaging is performed by scanning the sample using a precision piezo stage with an xyz travel range of ±31.5 mm. A photo of the MeV SIMS setup with collimated ion beam is shown in the figure below.



@ Analytical Chemistry, ACS

As in the setup with glass capillary, TOF of desorbed molecules is measured in the following way:

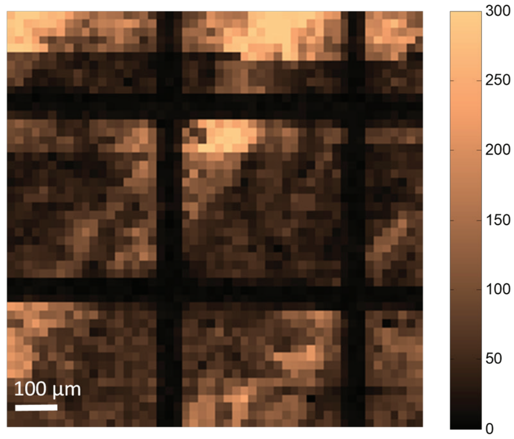
1. The extraction voltage is at zero potential to ensure that secondary electrons are not attracted towards the sample holder.

2. When ion passes through the carbon foil, secondary electrons are emitted and deflected toward the SE detector.

3. Upon electron detection, the signal from the SE detector is used to trigger high voltage switch (HV) to increase the extraction voltage at the target to a value of +3 kV.

4. HV on target is "on" for a duration of 2 µs, which is sufficient to detect all molecules in the mass range up to a few 1000 Da.

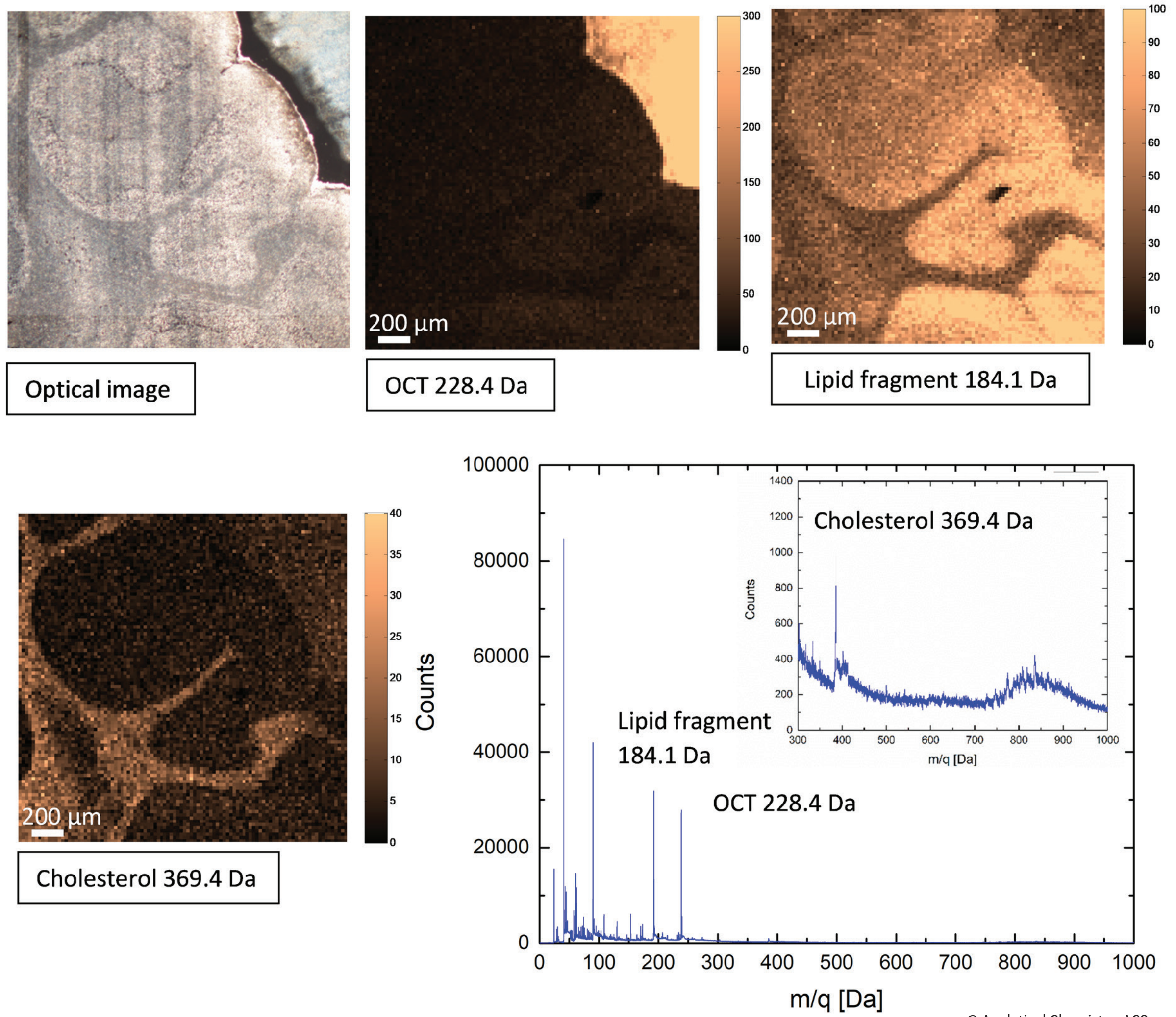
5. During the period of TOF measurement (~100 µs), there is a VETO for the data acquisition system (DAQ) to accept another START signal and start a new increase of the extraction voltage through the HV switch. In this way, the probability of random coincidences is minimized and the random noise in the mass spectra is reduced.



@ Analytical Chemistry, ACS

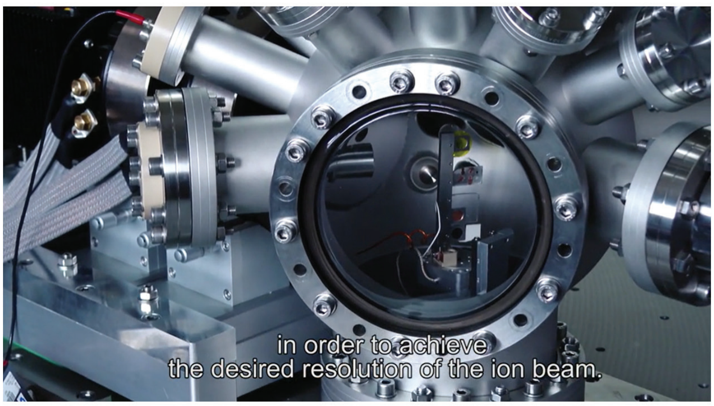
Influence of 5 nm carbon foil on the final beam lateral size for 14 MeV Cu^{4+} was tested on patterned phthalocyanine sample, evaporated on Si through 462 µm grid with bar size of 95.4 µm. Resulting total 2D image is presented at the following figure. According to the image, the lateral resolution is less than one image pixel which corresponds to 20 µm. Assuming a collimator aperture of 10 µm, the lateral ion beam straggling through the 5 nm carbon foil contributes less than ≈17 µm to the total lateral resolution. Thus, there is no significant difference in lateral resolution between a 5 µm and a 10 µm collimator, but the ion beam current is higher by a factor of 4 in the latter case.

The imaging capabilities of the new MeV SIMS setup are demonstrated on thin sections of mouse brains prepared according to a standard protocol for SIMS analysis and deposited on Si wafer. As for the resolution test, the same 14 MeV Cu^{4+} ion beam was used for imaging. The obtained MeV SIMS images of selected mass peaks (lipid fragment M=184.1 Da, cholesterol M=369.4 Da and OCT medium M=228.4 Da) and mass spectra are shown in the following figure. The corresponding optical image is also shown (image size: 2 mm x 2 mm).



@ Analytical Chemistry, ACS

In summary, we have demonstrated the imaging capabilities of a new MeV SIMS setup based on a continuous collimated ion beam with a target-independent system for START triggers in TOF measurements (with modest lateral resolution). The results presented show the great potential of the method for chemical imaging of organic materials found in many research areas, especially biology and forensics.



Screenshot from the video clip @ JSI

Nanobeams – how do we do it?

Jožef Stefan Institute (JSI) produced a video about the creation of their new nano beamline for analysis. Watch at https://www.ionbeamcenters.eu/jsi-poject-nanobeam-video/

A multimodal desorption electrospray ionisation workflow enabling visualisation of lipids and biologically relevant elements in a single tissue section

Catia Costa, Janella de Jesus, Chelsea Nikula, Teresa Murta, Geoffrey W. Grime, Vladimir Palitsin, Véronique Dartois, Kaya Firat, Roger Webb, Josephine Bunch, Melanie J. Bailey

In a recent article published in MDPI Metabolites (https://doi.org/10.3390/metabo13020262), researchers from the Surrey Ion Beam Centre (UK) explore the combination of desorption electrospray ionisation-mass spectrometry (DESI-MS) and ion beam analysis (IBA) to provide molecular and elemental information from a single tissue section. Previous publications described how the primary ion beam used for IBA (2.5 MeV H^+, in this case) causes significant molecular damage to the sample, precluding any sequential molecular mass spectrometry measurements [1]. Consequently, it is important that mass spectrometry imaging experiments preceed IBA. The choice of solvents used for DESI-MS analysis is extremely important as commonly used solvents (e.g. 95:5 (%v/v) methanol:water) caused delocalisation of elements such as chlorine (Cl) and potassium (K) [2]. In this recent publication, the authors describe how selecting a different solvent combination (50:50 (%v/v) methanol:ethanol) preserved the elemental composition and distribution of the tissue section, whilst maintaining the coverage and performance of the DESI-MS experiments.

[1] Costa, C., et al., Exploring New Methods to Study and Moderate Proton Beam Damage for Multimodal Imaging on a Single Tissue Section. Journal of the American Society for Mass Spectrometry, 2022. 33(12): p. 2263-2272.
[2] de Jesus, J.M., et al., Correlative Imaging of Trace Elements and Intact Molecular Species in a Single-Tissue Sample at the 50 μm Scale. Anal. Chem., 2021. 93(40): p. 13450-13458.

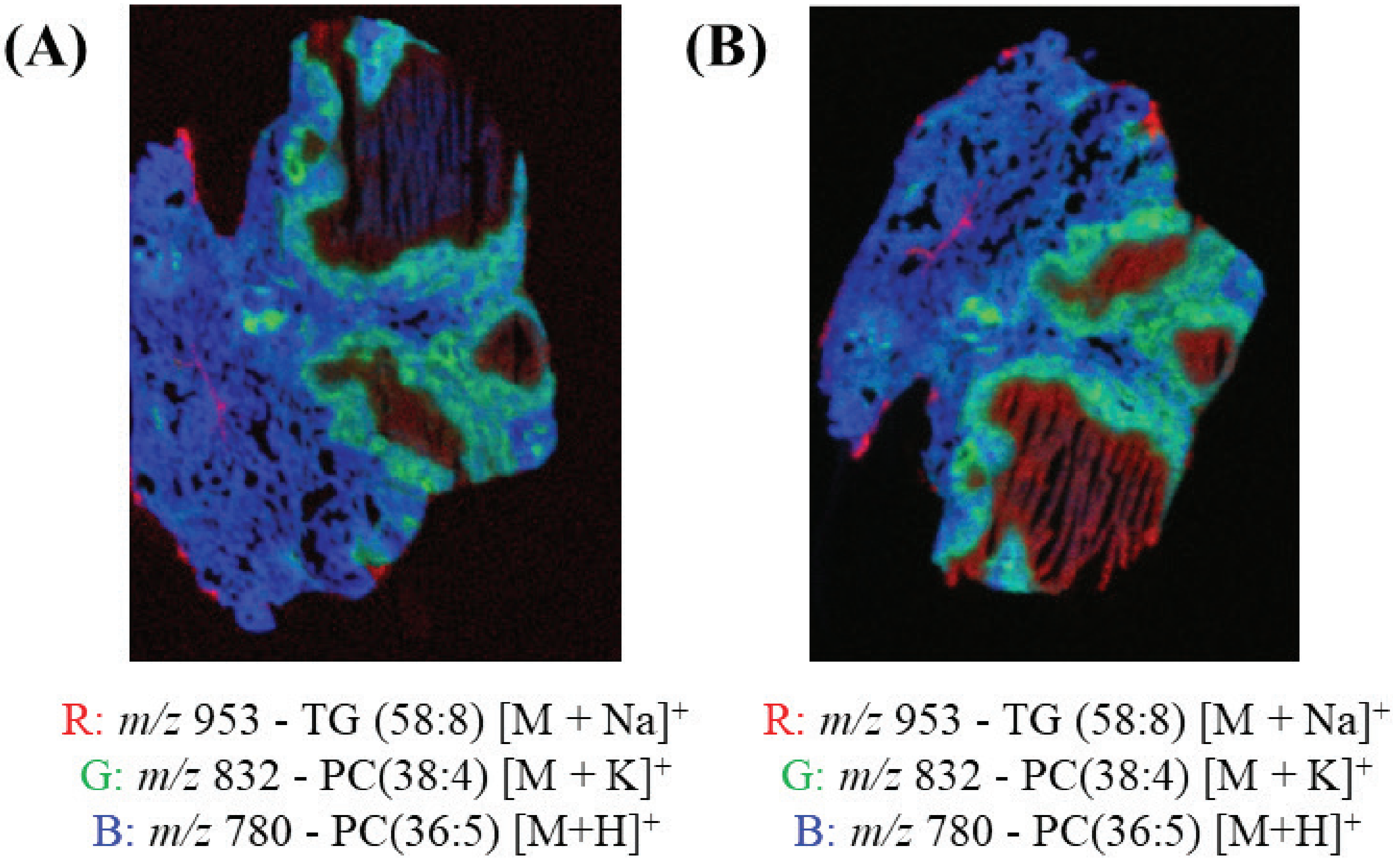


Figure 1: Overlay of DESI-MS ion maps of a rabbit lung presenting a TB granuloma analysed using (A) 95:5 (%v/v) MeOH:H2O and (B) 50:50 (%v/v) MeOH:EtOH. © MDPI Metabolites

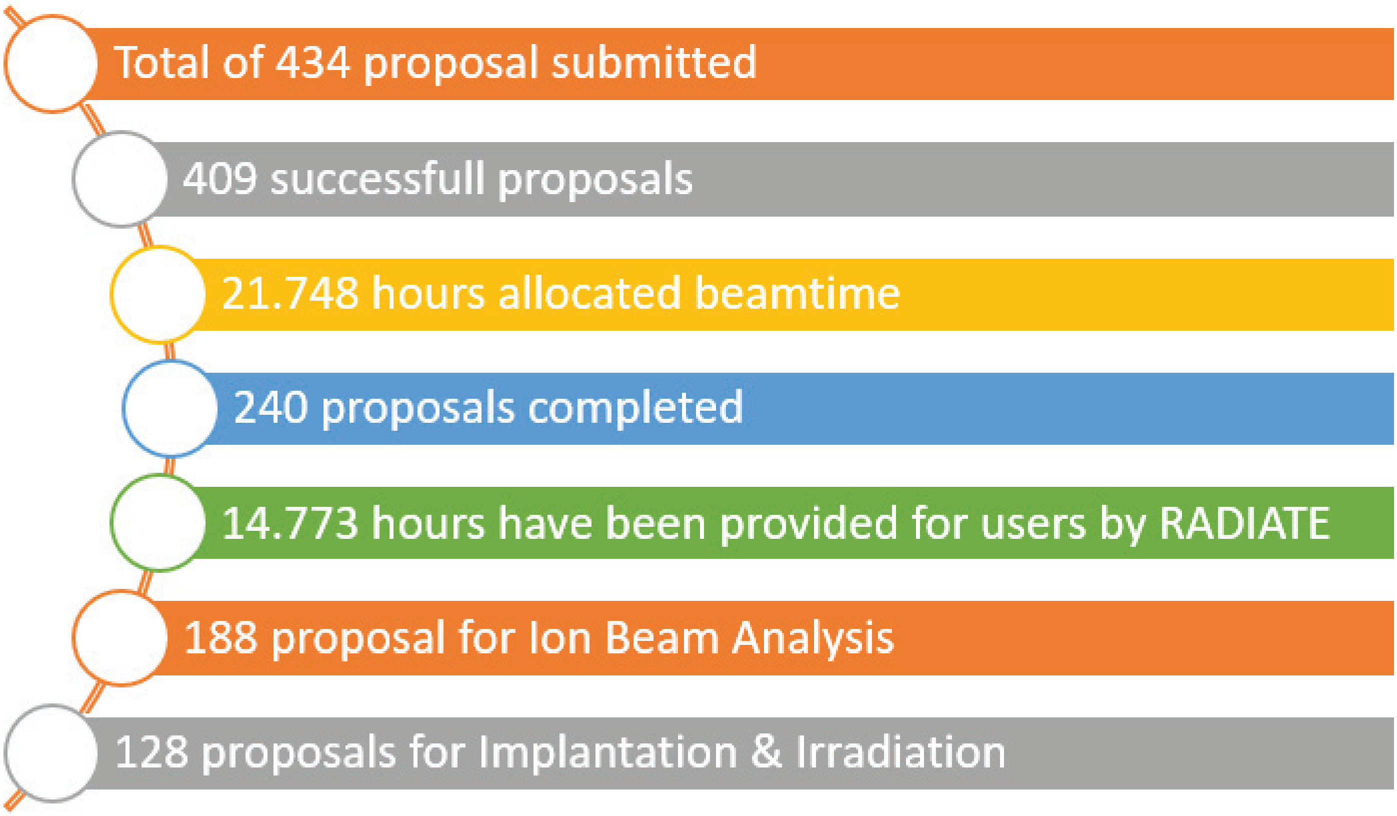
RADIATE TA Statistics

By Stefan Facsko

Shortly before the end of RADIATE on 30th of June, the proposal submission activity increased substantially: 50 proposals have been submitted in the first month of 2023, which is almost double the average number submitted in the past quarters.

In total, 434 proposals have been submitted, out of which 409 have been accepted with 21.748 hours allocated beamtime. Until now 240 proposals have been successfully finished and a total of 14.773 hours have been provided for users by the RADIATE ion beam centers. For 183 proposals a report has already been submitted. Most of the proposals have asked for Ion Beam Analysis (188), followed by Implantation & Irradiation (128) and by AMS (93).

The high worldwide interest in RADIATE is demonstrated by 530 registered users in GATE: 419 from EU, 37 from associated and 74 from non-EU countries. The majority are from Germany, Spain, UK, Italy, France and Austria. Among the non-EU countries US and India are the most prominent, closely followed by Australia and Brazil.



Proposal submission system now closed!

New proposals cannot be submitted in RADIATE's proposal submission system anymore. The system closed on 31 March 2023. Beam time for accepted proposals is still possible until 30 June 2023, the last day of the project.

RBS and PIXE studies of laser-induced reactions at the nanobeam line of the Surrey IBC

By Goele Magchiels

Within the quantum-solid state (QSP) group of the KU Leuven, heat-driven reactions in metal-semiconductor bilayers are studied. In thermal annealing studies the entire sample is heated, allowing broadbeam RBS experiments to obtain the compositional depth profile as a function of the annealing temperature. On the contrary, the ultrafast laser irradiation of the bilayer results in a local heating. The size of the laser-affected region is limited by the laser beam spot size (~10 µm) and the induced lateral heat and elemental diffusion. This brought Goele Magchiels (KU Leuven, PhD student) and André Vantomme (KU Leuven, Prof.) to the Surrey Ion Beam Centre. Assisted by Pierre Couture (Surrey IBC, Research Fellow) and Jonathan England (Surrey IBC, Prof.) RBS and PIXE measurements were performed. The scanning of the micron-sized ion beam spot through the laser-affected regions resulted in a compositional, depth and spatial sensitive analysis.

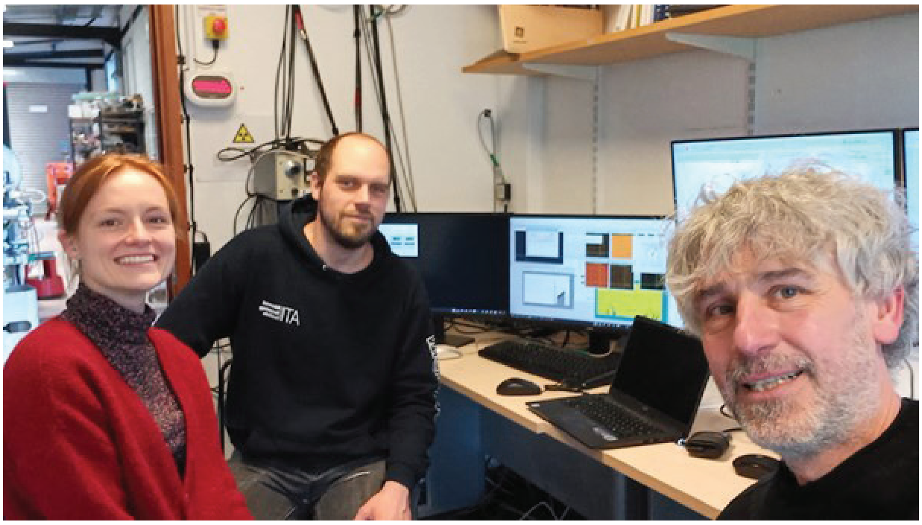


Figure: from left to right Goele, Pierre and André at the Surrey IBC control room. © KU Leuven

The experiments were repeated for a range of applied laser fluences. The in-person transnational access allowed a swift experimental campaign leading to novel insights in ultrafast laser-induced reactions. Moreover, it was a very educational visit with extensive explanations about the technical details of the beam lines and the available ion beam analysis techniques at the IBC. It was an inspiring visit which will be followed by another campaign at the IBC to continue the study of the laser-induced metal-semiconductor reactions.

Timing of glacial retreat in the Alpine Foreland by ^{36}Cl exposure dating of erratic boulders

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2Ludwig-Maximilians-Universität München, Department of Earth and Environmental Sciences, Luisenstr. 37, 80333 Munich, Germany.

3ETH Zurich, Department of Earth Sciences, Sonneggstrasse 5, 8092 Zurich, Switzerland.

Glaciers represent a delicate balance between snow accumulation in the upper reaches and ice melting at the toe. Therefore, they are susceptible to changes in temperature and precipitation, making them one of the most critical indicators of climate change. In the Alps, the retreat of large piedmont glaciers following the Last Glacial Maximum (LGM) has been recognized since the mid-19th century through studies of glacial sediments and landforms (such as moraines). However, only few ages for the moraines of the German Alpine Foreland are available – in contrast to a wealth of data for Switzerland. Thus, the post-LGM glacial dynamics of Germany are poorly understood.

We studied the retreat of the Iller piedmont glacier (southern Germany, see Fig. 1), which is one of the multiple glacier lobes that extended into the northern Alpine foreland during the last glacial period. We sampled erratic boulders on moraines of the LGM and two retreat stands to determine their depositional ages. These boulders are composed of a conglomerate containing primarily limestone cobbles, which permitted us to use in-situ cosmogenic ^{36}Cl to determine the exposure duration of these boulders to cosmic rays. We measured the ^{36}Cl concentrations in rock samples and accounted for the production by cosmic rays and its decay with a half-life of ~300 ka. The resultant ages indicate how much time has passed since the exposure to cosmic rays began, which is the time at which the glacier deposited the boulders in their present position as it was retreating.

We processed 21 rock samples and measured ^{36}Cl concentrations at DREAMS (Dresden Accelerator Mass Spectrometry facility) at HZDR (Helmholtz-Zentrum Dresden-Rossendorf), the laboratory for cosmogenic nuclide extraction at BOKU (Universität für Bodenkultur Wien), and VERA (Vienna Environmental Research Accelerator) at the University of Vienna, in collaboration with Silke Merchel, Stephanie Neuhuber, Anton Wallner, Georg Rugel, Johannes Lachner, Peter Steier, Martin Martschini, Alexander Wieser, and Oscar Marchhart. We also thank Kathrin Strößner, Katharina Boie, Hagen Hoemann, Sami Akber, Paul Herwegh, and Kaja Schulz for assistance with sample preparation.

This collaborative work was supported by RADIATE grants 21002431-ST and 20002195-ST as well as German Research Foundation (DFG) grant FR1673 15-1. We calculated the local production rate of ^{36}Cl in each rock sample from its major and trace element composition, derived from X-ray fluorescence, inductively coupled plasma mass spectrometry, and isotope-dilution AMS, accounting for production by spallation, epithermal neutrons, thermal neutrons, slow negative muons, and radiogenic production.

Field observations of boulders (Fig. 2) revealed characteristic dissolution features (karst grooves), which indicate that the ^{36}Cl ages must be corrected for erosion. Assuming an average erosion rate of the boulders of 18.5 mm/ka, we obtained 21 corrected exposure ages ranging from 10 to 19 ka (Fig. 1). The oldest ages of the LGM (Ziegelberg) and the first retreat stand (Eichholz) are within uncertainty of each other at 19-18 ka, suggesting a retreat and rapid break-up of the piedmont glaciers as a response to post-LGM warming. This is consistent with observations in Switzerland, Austria, and on the southern side of the Alps. The present compilation of data suggests that retreat and ice decay may have started 1-2 ka later in the east than in the west. We interpret the ages of 15-10 ka present at each site (Ziegelberg, Eichholz, and Käsers/Vockenthal) to be related to the inception or acceleration of the erosion of the moraines during the Bølling–Allerød warm period (starting at 14.7 ka), which might have uncovered partially buried boulders. These new data illuminate the timing of the LGM in Germany and the post-LGM retreat of a piedmont glacier due to rapid climate change.

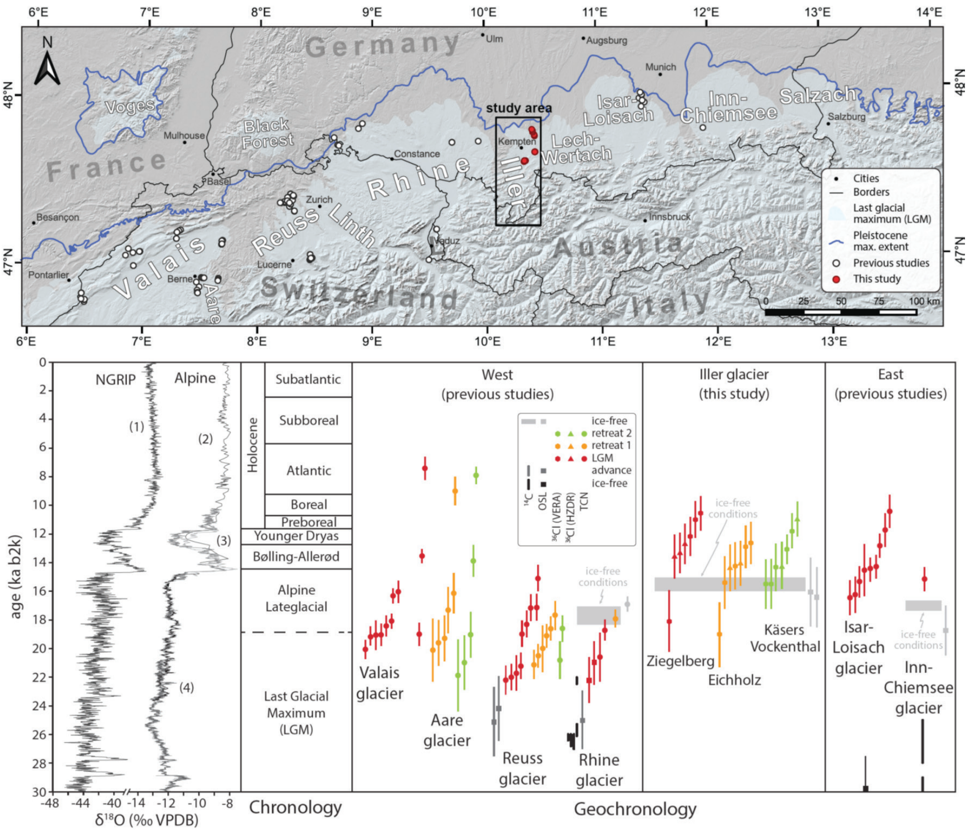

Figure 1: Map of piedmont glaciers in the Northern Alpine Foreland of France, Switzerland, Germany, and Austria. The study area (Iller glacier) is located near the center of the map. Below are the 36Cl-dating results, compared to cosmic ray exposure ages of boulders from previous studies as well as climate proxy data from Greenland (NGRIP) and the Alps. © University of Alaska Fairbanks

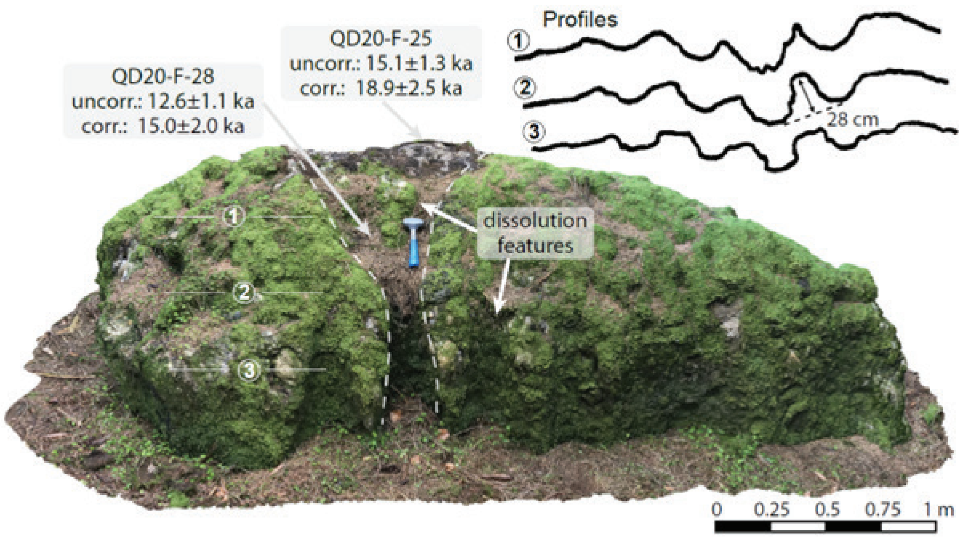

Figure 2: 3D model of one of the sampled glacial erratic boulders showing evidence of karstic erosion (dissolution features). The amount of eroded material can be estimated from surface profiles. A sample taken from an eroded area yielded a lower apparent age than one from the less-eroded top of the boulder. Based on this calibration, an erosion correction was applied to all ages. © University of Alaska Fairbanks

We want your publications!

If you have any publications resulting from your TA beam times, please let us know about it so we can include it in our report and on www.ionbeamcenters.eu - just send a short message to Astrid Berens at a.berens@hzdr.de

Guest Researcher at HZDR

© Abdennacer Nakbi Midaoui

Hello! My name is Abdennacer Nakbi Midaoui. I am working in the Centre of Microanalysis for Materials at the University Autónoma de Madrid as Accelerator Support Engineer and Main Supervisor of Radiological Protection. The purpose of the visit to Dresden accelerator is to exchange experiences about accelerator operation, electronic test electronics methodologies in order to contribute to the improvement of the technical and scientific activities. At CMAM we collaborate with external users in experiments that apply IBA analysis techniques such as RBS, ERD, PIXE, NRA, channelling, as well as irradiation experiments for the modification of materials. My interest was to see and experience in the host institute the details of implementation of some of these experimental techniques, in order to have a complementary experience to what we do at my home institute and identify possibilities for improving work procedures. In particular, I would be very interested to see data acquisition and instrumentation details of the experiments for H detection with He-ERD, which is one of the ongoing efforts at CMAM, as well as the complementary approach of doing H detection by ^{15}N beam in NRA line. I am also interested in all aspects of the implementation of the experiment, starting from the ion source. These techniques have been promoted in recent months at the CMAM in collaboration with local group that works on hydrogen storage and detection, based on hydride thin films. The proper choice of absorber sheets, the geometric configuration of the sample and the detector with respect to the beam (He-ERD), the effective solid angle subtended by the gamma ray detector as seen from the sample, the expected number of counts for a given time acquisition (for the NRA 15N) and the experience reached in general (for both types pf experiments), they will be very useful for our research work in CMAM. Also I have great interest in sharing information in the field of radiation protection because working safely is our main goal.

Looking to the future - ReMade@ARI - CALL ANNOUNCEMENT

Are you motivated to develop materials for a circular economy?

Do you have a brilliant scientific or industrial idea?

Are you faced with a specific challenge in your circular materials research?

ReMade@ARI has the best existing analytical facilities, instrumentation, methods, and the know-how to use them for advanced materials characterization! As a hub dedicated to developing new materials for a circular economy, ReMade@ARI provides scientists exploring the properties and structures of recyclable materials with coordinated access to more than to over 50 analytical research infrastructures across Europe comprising high magnetic fields, synchrotrons, free-electron lasers, neutron sources, and ion or positron beams.

Users can now submit proposals for access to these infrastructures with a single, easy-to-use application portal. Applicants are also welcome to submit a pre-proposal to receive support from the scientific network of ReMade@ARI to develop their idea into a full proposal.

The deadline for proposal submission is 30 April 2023.

For further details, please check out the website https://remade-project.eu/ or contact info@remade-project.eu.

Upcoming conferences

May

7-12 May 2023 - **IPAC2023** (14th International Particle Accelerator Conference), Venice, Italy
https://www.ipac23.org/

7-12 May 2023 - International conference on analytical techniques in art and cultural heritage (**TECHNART 2023**), Lisbon, Portugal
https://technart2023.com/

21-25 May - 50th IEEE International Conference on Plasma Science (**ICOPS 2023**), Santa Fe, NM, USA
http://ece-events.unm.edu/icops2023/

29 May - 2 June - European Materials Research Society (**E-MRS**) spring meeting, Strasbourg, France
https://www.european-mrs.com/meetings/2023-spring-meeting

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

June

7 - 9 June - European FIB Network (**EUFN**), Zurich, Switzerland
http://www.eu-f-n.org/2023-2/

15-16 June - RADIATE Final Meeting, Split, Croatia

26-30 June, International Conference on Materials for Advanced Technologies (***ICMAT2023)***, Singapore
https://icmat2023.mrs.org.sg/

July

17-19 July, 3rd FIT4NANO workshop, Lisbon, Portugal
https://www.fit4nano.eu

September

3-8 September - 21st International Conference on Radiation Effects in Insulators (**REI-21**), Fukuoka, Japan
https://rei21.kyushu-u.ac.jp/index.html

18 - 21 September - European Materials Research Society (**E-MRS**) Fall Meeting 2023, Warsaw, Poland
https://www.european-mrs.com/meetings/2023-fall-meeting

October

7 - 13 October - 26th International Conference on Ion Beam Analysis (**IBA-2023**) and the 18th International Conference on Particle Induced X-ray Emission (**PIXE-2023**), Toyama, Japan
https://ion-beam.jp/IBAPIXE2023/

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