Issue # 6 - February 2022

Newsletter

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RADIATE: carry on!

As we emerge from two years of COVID-19 chaos and enter the final year of RADIATE, we can look back at the last three years of developments in ion beam technologies. One of the RADIATE's big goals is to bring new users from industry and academia to the 14 ion beam facilities around Europe through provision of transnational access (https://www.ionbeamcenters.eu/radiate/radiate-transnational-access/). Since the start of the project in 2019, RADIATE project partners have received 245 proposals and delivered just under 8320 hours of beam time. These projects touched on diverse and multidisciplinary subjects which included biology, geology and materials science. This shows the wide applicability of ion beam technologies and how it can serve the many branches of science and industry.

Through Joint Research Activities (https://www.ionbeamcenters.eu/radiate/joint-research-activities/), RADIATE ensures that the future of ion beams are under continuously development. JRA projects looked to develop ion beam sources, detectors and software to ensure better, more reliable tools for ion beam analysis and material modification.

Finally, as we look to the next generation of ion beam scientists and users, RADIATE offers all sorts of training opportunities through Summer Schools, Guest Research and Twinning Programs (https://www.ionbeamcenters.eu/radiate/training/). Whilst these have been heavily impacted by travel restrictions, we hope that in 2022 we train and inspire the next generation.

All in all, and despite the setbacks caused by the pandemic, RADIATE has so far been a very resourceful and productive project. We hope 2022 allows us to resume our normal activities and the much needed in-person meetings, conferences and workshops.

RADIATE

In this edition read about:

RADIATE Contact

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NEWSLETTER EDITORIAL

Catia Costa
University of Surrey

@ionbeamcenters

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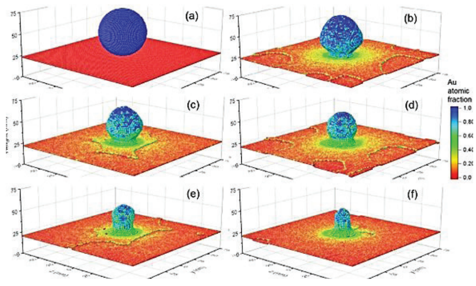
https://www.ionbeamcenters.eu/radiate/radiate-newsletter/

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

TRI3DYN software available



© W. Möller

HZDR's TRI3DYN is now available for Linux and MS Windows environments. TRI3DYN computer simulation describes ion irradiation effects in three-dimensional amorphous multi-component material systems, and keeps track of the local dynamic modification and the development of the surface contour of the system due to ion implantation, atomic relocation and sputtering. For more information see here

https://www.hzdr.de/db/Cms?pNid=2689&pOid=64858

RADIATE Personnel news

Zoltan Tamas Gaal has recently joined the RADIATE project as a PhD student. In his doctoral work he studies heavy ion beam effects in bulk materials. In the RADIATE project he works on optimizing the micro- and nanobeam lines at Atomki. He has gained his BSc degree in physics (biomechanic investigations), and his MSc in materials science (PIXE experimants) at the University of Debrecen.

© Z. Gaal

Imaging of Organic Samples with Megaelectron Volt Time-of-Flight Secondary Ion Mass Spectrometry Capillary Microprobe

Marko Brajković, Iva Bogdanović Radović, Marko Barac, Donny Domagoj Cosic and Zdravko Siketić

https://pubs.acs.org/doi/10.1021/jasms.1c00200

In the article recently published in the Journal of the American Society for Mass Spectrometry (https://pubs.acs.org/doi/10.1021/jasms.1c00200) the group from the Ruđer Bošković Institute in Zagreb demonstrated imaging capabilities of MeV SIMS setup using conically shaped glass capillary. One advantage of using capillary is ability to use heavy primary ions with high energy (such as 20 MeV Iodine) which produce a higher secondary ion yields and which are not easily focused with standard electrostatic or magnetic focusing lenses. Beam collimated by capillary consists of two distinct parts: a core, made of ions directly transmitted through it, and a halo. The halo is made of ions that are either scattered form the capillary walls or are sufficiently energetic to pass through the thin capillary walls close to the capillary tip. Halo is different for every capillary and its contribution could be sometimes large thus detoriating significantly imaging capabilities.

Two setups with continuous primary ion beam were investigated for capillary collimated beam. First setup works for thin, transmission targets and uses particle detector behind the sample to start the TOF measurement. Second setup was designed to enable the analysis of arbitrary thick targets. In this setup, as a trigger to start the TOF measurement, secondary electrons released from the target upon primary ion impact were used. The implementation of electron detection was complicated due to the fact that target is normally biased to the high positive voltage to accelerate positive secondary ions toward grounded extractor. To resolve this issue, a high voltage transistor switch (Behlke HTS 61-01-GSM) was introduced to change the target voltage from zero to acceleration voltage and vice versa in a very short time. Operation of a switch can be seen on Figure 1.

When the primary ion hits the sample placed firstly on a grounded sample holder, secondary ions and electrons

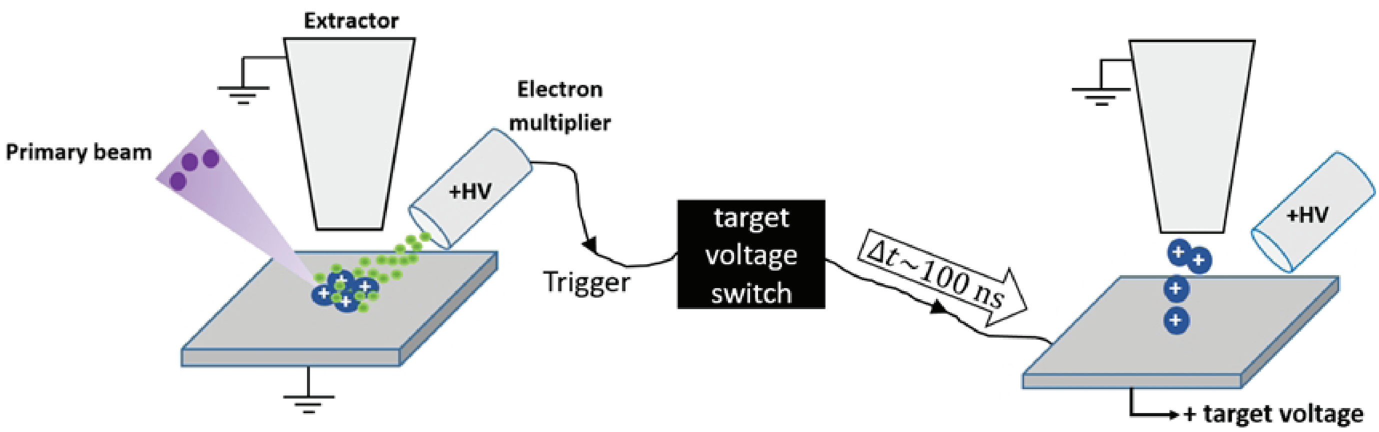


Fig. 1: Trigger for thick target MeV SIMS measurement with continuous primary ion beam using secondary electrons for start of TOF measurement and high voltage switch © JASMS

are released from the sample. Emitted secondary electrons are collected in a very short time (few ns) by electron multiplier placed about 10 mm from the sample holder. The logical signal from the multiplier is used as a start signal for the TOF measurement. Additionally, a digital signal from the acquisition system is sent to the switch which then increases the target voltage. The delay between the start signal, from the electron multiplier, and the signal to the control gate of the switch is about 80 ns and no significant loss of secondary ions is expected during this delay. After increasing target voltage, the secondary ions are accelerated toward extractor. Two µs later, the target voltage is switched back to zero and during the time interval of 100 µs, which is a window for TOF measurement, the acquisition system prohibits triggering of the switch.

Lateral resolution of the setup was tested on the leucine-evaporated carbon-coated Cu mesh using 8 MeV Cu^{3+} ions and the thin target (transmission mode) setup. The capillary exit diameter (~ 2.5 µm) defines beam core diameter which is increased at the target due to beam divergence (~1°, defined by ~ 1 mm collimator opening 1.5 m before the capillary). For lateral resolution measurement, the leucine-evaporated carbon-coated copper mesh was placed on a scanning stage and the setup was operated in transmission mode with the 8 MeV Cu^{3+} primary beam. The beam current at the capillary inlet was used for the normalization of the piezo stage movement. Measured resolution in x direction was 3 – 8 µm, depending on the side of the mesh edge. As the angle between capillary axis and normal to the sample surface is 45°, it is expected that one side of the mesh appears sharper than the other. The resolution in y direction was worse (15 – 17 µm) due to the fact that the collimator placed in front of the capillary chamber cuts the beam only in x direction.

Imaging capabilities of a capillary microprobe setup for thick targets with electrons used as a start trigger was tested on sample consisting of ink deposited on a paper. An area of 1 x 1 mm^2 (20 µm per pixel) was analyzed using 14 MeV Cu^{4+} primary ions. A signal from electronic multiplier was used for normalization and triggering of the scanning stage movement (multiplier/ion beam rate was approximately constant in all regions of analyzed area). Results can be seen in figure 2.

Spatial distribution of molecules from the Basic Violet 3 (BV3) pigment shows clear correlation with the ink distribution. Looking at the number of counts in the areas where no ink was deposited, it can be concluded that halo contribution is quite strong – average number of counts in these parts of the imaged area goes from 10% (lower right corner) to more than 50% (upper left corner) of the average number of counts in the parts with deposited ink. Sodium is homogeneously distributed over the analyzed area, which is expected, except for the stronger signal in the upper part of the image, as a consequence of the asymmetrically shaped beam halo.

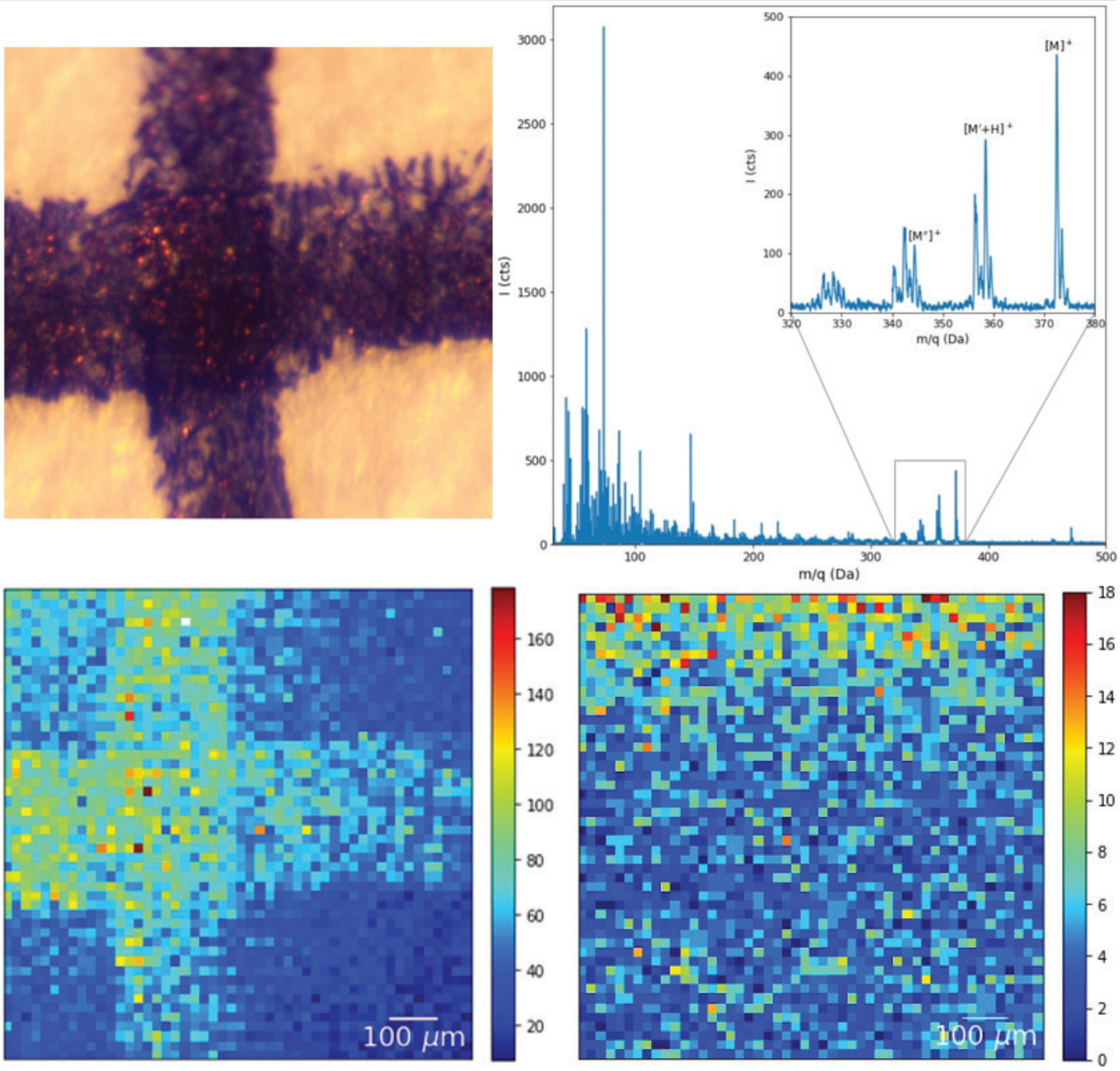


Fig. 2 Imaging of ink deposited on paper with electrons as start trigger: a photo of the sample (upper left), total mass spectrum with characteristic peaks (BV3 pigment and its degradation products and fragments: M = 372.5 Da, M' = 357.5 Da and M'' = 344.4 Da) featured in the inset (upper right), spatial distribution of the BV3 products and fragments from the mass spectrum figure inset (lower left), and spatial distribution of sodium (lower right). © JASMS

RBS HEDGEHOG - A New Ultra-High Sensitivity RBS Setup at HZDR

René Heller, Nico Klingner, Robert Aniol, Mario Steinert, J.v. Borany

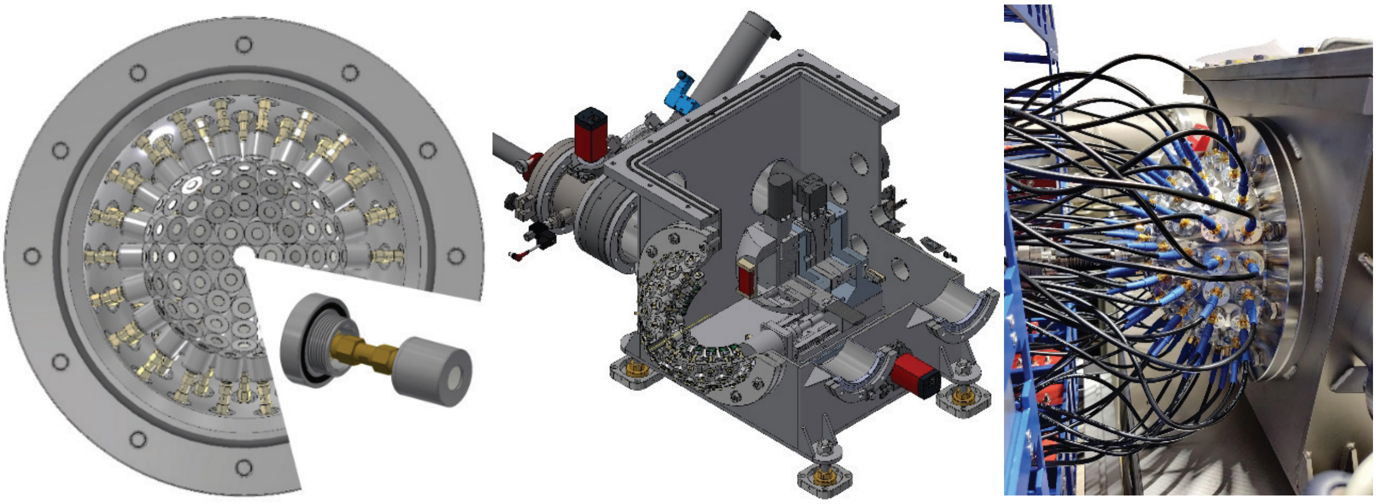


Fig. 1: RBS hedgehog detector arrangement and mounting (left), entire experimental setup (center) and detector dome + wiring (right).© HZDR

Rutherford Backscattering Spectroscopy (RBS) as one of the most widely used ion beam analysis methods requires a rather high ion beam fluence due to the small backscattering cross-section. Although the lack of measurement statistics can be compensated by a longer measurement time, this can only be applied to macroscopic beam spots and is not possible for sensitive samples or in a micro beam setup. Higher beam currents on the other hand would lead to increased pile-up contribution and thus reduce sensitivity for low abundance or trace elements.

Larger detectors are an easy means to increase the covered solid angle, however this is limited in terms of kinematic broadening and decreasing energy resolution due to increasing detector capacitance [1]. Multi-detector setups overcome this limitation and are attracting increasing interest in various laboratories. Geometric constraints, mechanical robustness, the cost of multiple MCA systems, as well as the difficulty of simultaneously analyzing data from the individual detectors make this a difficult but worthwhile endeavor.

In 2021, we commissioned a new experimental end station for RBS with highest solid angel at our 3 MV accelerator. Core of this setup are 76 Si-detectors arranged in 5 concentric rings around the sample. All detectors within one ring have intrinsically the same backscattering angle and their spectra can thus (after proper calibration and binning) be added to one common sum spectrum. Thus, in the end the 76 detectors just produce 5 spectra of different scattering angle, with each single detector having a solid angle of 9 msr, yielding in a total solid angel of 681.4 msr or 9.2% of the entire half sphere for backscattering. The setup enables acquisition of RBS spectra with highest sensitivitiy and channeling maps on an extraordinary short time scale.

Since this experiment required a high number of Si-detectors, we decided to fabricate them in-house. This included the design, processing (incl. ion implantation), characterization and cutting of wafers as well as the design and fabrication of proper detector housing and mount. A detailed scheme of detector arrangement, experimental chamber and detector assembly is shown in fig. 1.

Since all detectors in the entire setup are operating independently from each other the tremendous increase of solid angle is not associated with a limitation in count rate, as if for instance would be the case if the solid angle would be realized by one or more big detector(s). The price to pay therefore is that each detector needs its own signal processing.

For this purpose, we developed a small, scalable and cost-efficient solution as shown in fig. 2. In a small metal cover of size 160mm x 105mm x 55mm a complete spectroscopy electronics is housed on a printed circuit board. It includes a pre-amplifier of type CR110, a main amplifier of type CR200, a base line restorer, an ADC, a multi-channel-analyzer and an Ethernet communication unit. The latter one brings in the scalability of the system since thus all electronics from all detectors can be brought together by a standard network switch.

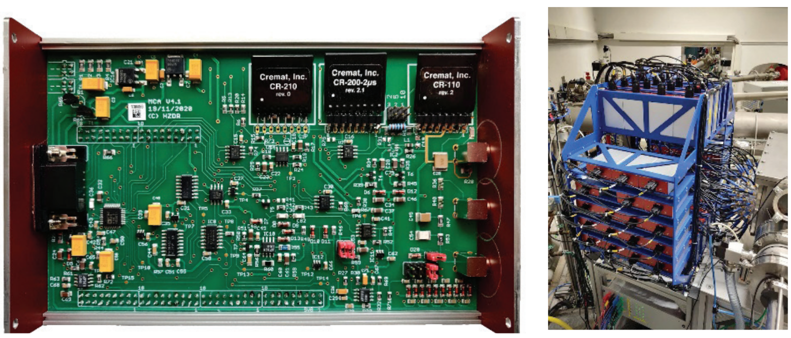


Fig. 2: Single detector signal processing unit (left) and entire detector-electronics mounted around the beam line, in front of the experimental chamber (right).© HZDR

During spectrum acquisition, each of the detector electronics operates completely independent from a.) the other detectors and b.) from the control PC. Periodically, the PC requests the spectra from each detector via Ethernet. In our control software, finally the spectra are collected and ring-wise added to each other.

The RBS hedgehog was commissioned during 2021 and first measurements were conducted beginning of August. The very first results have been presented at the IBA2021 conference in October. Fig. 3 shows a test measurement of a calibration sample, consisting of a carbon substrate on top of which Si, Ni and Au were deposited using masks of different size. Thus, a sample structure as shown in the inset of fig. 3 is created which produces an RBS spectrum (under 2MV He and Theta=170°) that consists of 3 plateaus of equal height and width plus the C bulk signal. In this way, it offers in total 4 surface edges (with equal statistics) to calibrate the detector.

The measurement shown in fig. 3 was acquired with a total charge of just 3.6µC corresponding to an acquisition time of approx. 3 minutes. An overall energy resolution in the order of 20-30 keV was measured for the different rings, although the energy resolution of the single detectors was proven to be much smaller (13-18 keV).

[1] Klingner, N., Vogt, J., & Spemann, D. (2013). NIMB, 306, 44-48.

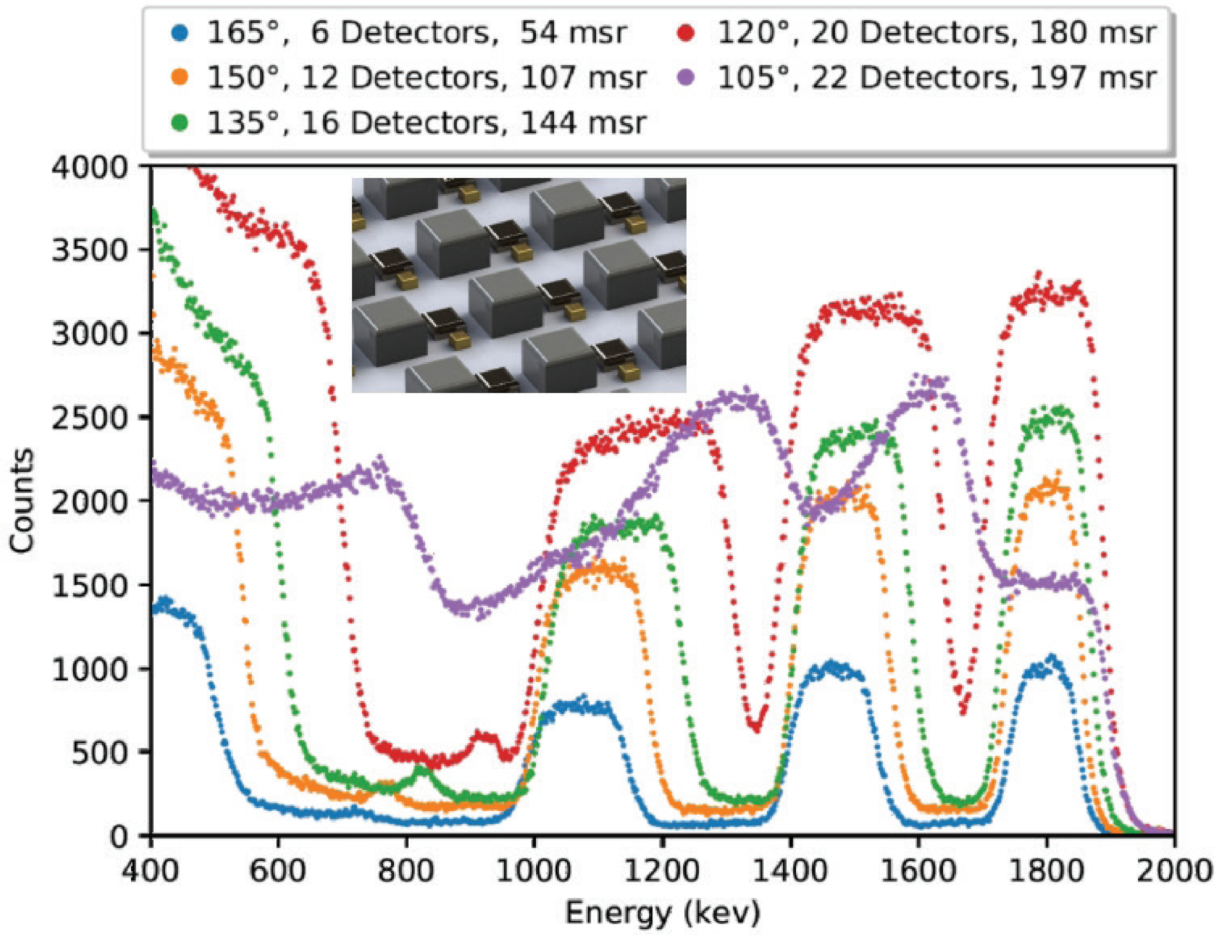


Fig. 3: RBS spectra of a calibration sample as measured from all 5 rings. Inset shows the sample structure as described in the text © HZDR

The search for ancient solar storms with accelerator mass spectrometry

Chiara I. Paleari [1], Florian Mekhaldi [1,2], Florian Adolphi [3], Marcus Christl [4], Christof Vockenhuber [4], Philip Gautschi [4], Jürg Beer [5], Nicolas Brehm [4], Tobias Erhardt [3,6], Hans-Arno Synal [4], Lukas Wacker [4], Frank Wilhelms [3,7] & Raimund Muscheler [1]

1 Quaternary Sciences, Lund University, Sweden; 2 British Antarctic Survey, Cambridg, UK; 3 Alfred Wegener Institut, Bremerhaven, Germany; 4 Laboratory of Ion Beam Physics, ETH Zürich, Switzerland; 5 Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland. 6 University of Bern, Bern, Switzerland; 7 University of Göttingen, Göttingen, Germany.

The Sun erratically expels large amounts of energetic particles (SEPs) that react with the Earth's atmospheric constituents leading to the production of cosmogenic radionuclides such as ^{10}Be, ^{36}Cl and ^{14}C. SEP events pose a danger to our modern society by threatening communication, electronic and power systems, as well as affecting satellite and aircraft operations and endangering the life of astronauts in space. Several SEP events have already been detected in ice cores and tree rings [e.g. 1,2]. These events are at least an order of magnitude larger than any event observed during the modern instrumental period. Hence, assessing the occurrence rate of such extreme SEP events is key for the development of up-to-date risk assessments.

Analyses of ^{36}Cl and ^{10}Be in ice core samples carried out at the Laboratory of Ion Beam Physics at ETH Zurich within a RADIATE transnational access proposal 20002060-ST led by Lund University resulted in the detection of a new extreme SEP event. Results of this study have recently been published in Nature Communications [3]. For this project, researchers analyzed 10Be and ^{36}Cl concentrations in ice cores from Greenland (GRIP, NGRIP and EGRIP) and Antarctica (EDML).

In order to achieve good time resolution and to make most out of the precious sample material the researchers applied a novel sampling strategy for the EGRIP ice core samples. They collected their samples during a Continuous Flow Analysis (CFA) campaign at the department of Climate and Environmental Physics (University of Bern) by sampling the outer part of the CFA ice samples, which otherwise would have been discarded. This resulted in small (50 ml) sample volumes for ^{10}Be with an average temporal resolution of ~0.85 years. The EGRIP ^{10}Be samples were prepared without the use of ion exchange chromatography with the addition of only 0.1 mg of ^{9}Be carrier. ^{10}Be /^{9}Be measurements were carried out on the new MILEA AMS system at ETH Zurich. ^{36}Cl concentrations were measured at the 6 MV Tandem accelerator using a gas filled magnet. Due to the low ^{36}Cl concentrations ice from four ^{10}Be samples was combined to one AMS ^{36}Cl sample.

The results of the ice core analyses provided unambiguous evidence of a solar storm occurring 9125 years BP (i.e. before 1950 CE). The event is also confirmed by radiocarbon measurements [4]. All radionuclide records consistently show a peak, detected in both ^{10}Be and ^{36}Cl, as well as ^{14}C (Fig. 1). The event caused one of the largest ^{10}Be peaks induced by a SEP event detected so far, possibly even larger than the 774/5 CE event [3], which is known as the so far strongest SEP event [2]. Further investigation on the timing of the event in relation to the phase of the solar 11-year cycle revealed that it occurred close to a minimum in the 11-year cycle.

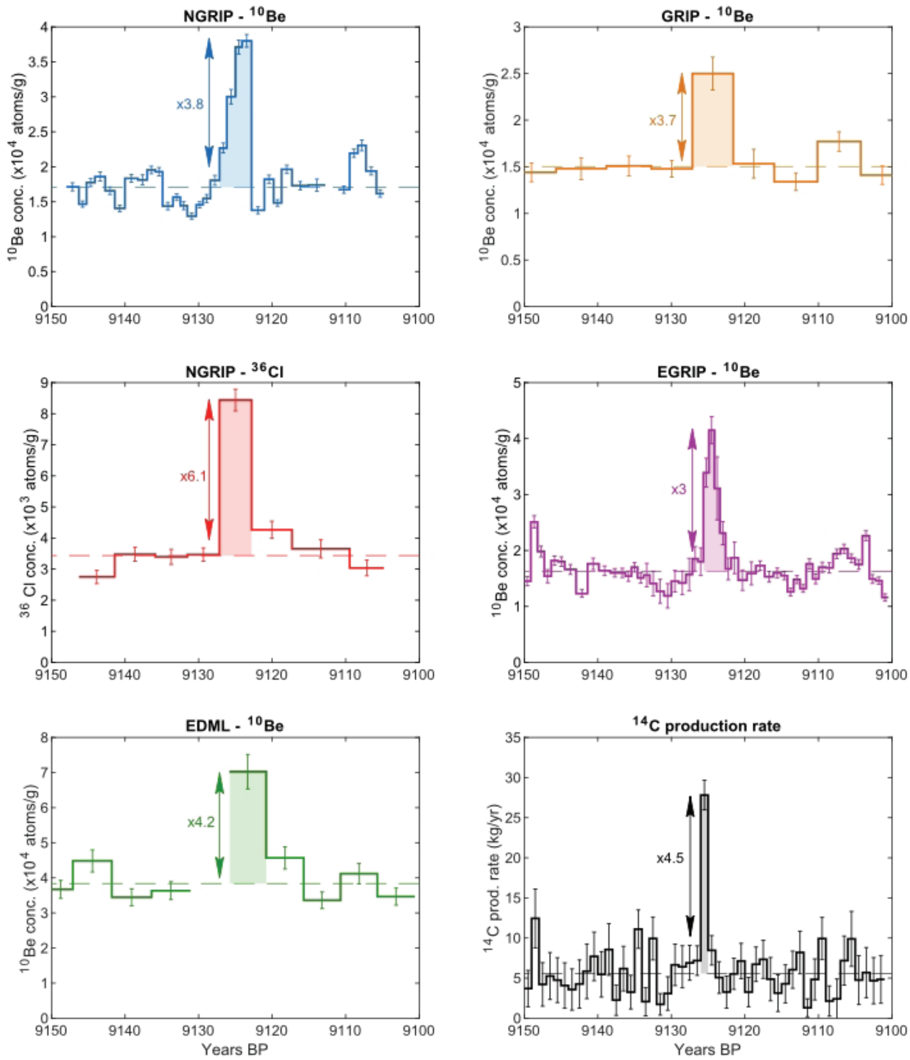


Figure 1: Figure 1. Available high-resolution 10Be, 36Cl and 14C records around 9125 years BP3,4. The numbers for the increase above the baseline are calculated from the integrated increase in relation to the average annual production. © Quaternary Sciences, Lund University, Sweden

The discovery of radionuclide peaks in ice cores and tree rings not only provides unique information on past solar activity, the signal also can be used as a precise time marker. This work, in fact, allowed the team to reduce the uncertainty in timescale synchronization between the Greenland NGRIP ice core and the ^{14}C (IntCal20) time scale to about one year around 9125 years BP.

[1] Miyake, F. et al., A signature of cosmic-ray increase in AD 774–775 from tree rings in Japan, Nature, 486, 240-242, doi:210.1038/nature11123, (2012).

[2] Mekhaldi, F. et al. The Signal of Solar Storms Embedded in Cosmogenic Radionuclides: Detectability and Uncertainties, J. Geophys. Res. Sp. Phys., 126, (2021).

[3] Paleari, C. et al., Cosmogenic radionuclides reveal an extreme solar particle storm near a solar minimum 9125 years BP. Nature Communications, 13 (1) DOI: 10.1038/s41467-021-27891-4, (2022).

[4] Brehm, N. et al. Tree-rings reveal two strong solar proton events in 7176 and 5259. Nat. Commun., in review.

Partner news

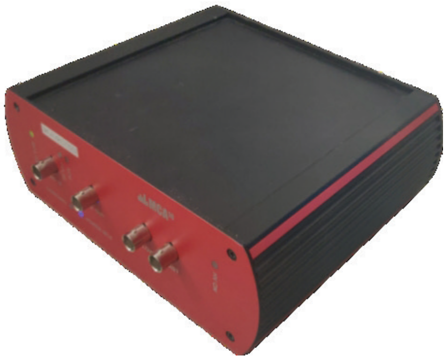
The innovation managers of RADIATE move into a next phase

Johan Meersschaut, imec

The consortium considers the innovation activities as an essential component of RADIATE. This goal is to promote methods and best practices to approach the industry and to meet their requirements. For this, the RADIATE consortium has reserved resources to support Atomki (Hungary), Ruder Boskovic Institute (Croatia), and Józef Stefan Institute (Slovenia) with a dedicated "innovation manager". The Innovation Managers support the transfer process of scouting, evaluation, exploitation planning, and acquisition of funds for validation, identification of appropriate partners as well as contract negotiations. They also organize awareness-raising seminars and matchmaking events between scientists and industrial partners. Finally, the Innovation Manager identify potential business opportunities from within, and assess the feasibility of a potential spin-off company at the respective infrastructure. Recently, the Innovation managers have presented a formal report about their market studies to the European Commission.

The appointment of innovation managers to oversee the innovation activities at their respective organizations has proven to be a great success. The innovation managers have performed an in-depth study of the business opportunities at their sites. Remarkably, in each of the institutions, it has been possible to identify a product that may be commercialized. For example, Atomki recognized that a new non-destructive Beam Energy Monitor for cyclic accelerators can be commercialized. At Ruđer Bošković Institute one recognized the potential to offer ion beam analysis as a commercial service, to offer a diamond radiation detector or a ToF-ERD telescope as commercial products. At Józef Stefan Institute, it was realized that a new Multi Channel Analyzer MCA 16 (figure 1) delivers cutting edge performance and has a competitive advantage through the openess of the software.

Having scouted the possibilities, in the next phase the innovation managers will start to exploit the unique opportunities in Europe



Multi Channel Analyzer MCA 16 developed at Józef Stefan Institute © JSI

and will continue to inspire their colleagues to strengthen the position of Europe regarding high-tech ion-beam-related industrial activities.

Acknowledgments

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824096. The author is grateful to the innovation managers Ida Srdic (RBI), Andrej Kosicek (IJS), and Richárd Rácz (Atomki) and to the people who support them.

Conference Report

25th International Conference on Ion Beam Analysis & 17th International Conference on Particle Induce X-ray Emission & International Conference on Secondary Ion Mass Spectrometry

The first joint Particle Induced X-ray Emission (PIXE) and Ion Beam Analysis (IBA) conference was due to take place in Toyama, Japan during October 2021. Similarly, the 23rd International Secondary Ion Mass Spectrometry Conference (SIMS23) was due to be held in Minneapolis, USA in September 2021. Unfortunately, due to the global pandemic both conferences were cancelled and moved to a virtual platform. Bringing these three conferences together in a single virtual venue was of great benefit to all three research communities by providing a level of information exchange that has not quite been available before.

The Surrey Ion Beam Centre accepted the challenge to organise the two conferences into a single virtual event with the help of the Institute of Physics between 11-15 October 2021. The event was hosted in GatherTown which enabled the participants to talk to each other in small and large groups and was used well for social and poster presentations. The conference attracted more than 270 participants from around the world. The meeting sessions were scheduled to enable people in all time-zones to interact with each other as much as possible without forcing everyone to be awake at "unreasonable hours". The meeting covered the usual scope of these three international conferences:

- Development of Ion Beam Analysis Techniques (including but not limited to SIMS, MeV SIMS, PIXE, NRA, ERD, RBS…)
- Applications of Ion Beams for the Analysis of Materials
- Development of Equipment
- Modelling & Theoretical Understanding

More information about each topic is on the website at http://iba2021.iopconfs.org/topics

173 presentations were made during the week, including many by our RADIATE partners from HZDR, Surrey, Uppsala University, CNRS, RBI, IST, ETHZ, University of Jyväskylä, JSI, KU Leuven and Ionoptika, for example.

The meeting was a great success with some people even preferring it to a real face-to-face meeting. Particularly noticeable was that attendance on the final day was as strong as on the first day, with no people leaving early to catch planes. The International Committees of the conferences both recognised that future conferences will have to have a virtual element for those unable or unwilling to travel long distances in an attempt to reduce their carbon impact.

© IOP

Conference Report

Applied Nuclear Physics Conference (ANPC) 2021

In September 2020, the first Applied Nuclear Physics conference (ANPC) was supposed to take place. This new conference, organized under the umbrella of the Nuclear Physics Division of the European Physical Society (EPS), offers "an open forum for scientists and engineers working in the wide field of nuclear applications with particular emphasis on energy, health, space, environment, material science, preservation and cultural heritage", as an opportunity to foster synergies with researchers from these different communities.

Unsurprisingly, the 2020 edition was cancelled… From September 12-17, 2021, a hybrid version of the conference was organized by Prof. Anna Mackova (Nuclear Physics Institute of the Czech Academy of Sciences, and a member of the RADIATE Advisory Committee) in Prague, with 124 registered participants, of which 66 onsite and 58 online. More information can be found on the ANPC 2021 website: https://www.anpc2021.cz/

© ANPC

ANPC hosted two IBA-Europhysics prize winners, Marco Durante (GSI, awarded 2013) and Thomas Haberer (Heidelberg University Hospital, awarded 2020, with a ceremony at ANPC), besides a variety of excellent speakers from the ion beam physics community.

The conference featured a total of 5 plenary talks, 26 invited talks, 56 contributed talks and 35 poster presentations, including 2 plenary, 6 invited and 14 contributed talks and posters by RADIATE partners from IST Lisbon, KU Leuven, Uppsala, HZDR, INFN and RBI, and Eline Ntemou (Uppsala Universitet) won a best poster award.

© ANPC

Upcoming conferences

April

6-8 April – **4th International Conference on Radiation and Emission in Materials (ICREM)**, Pattaya, Thailand
http://www.nano.kmitl.ac.th/icrem2021/

12-14 April - **Semiconductor and Integrated OptoElectronics Conference (SIOE)**, Cardiff, Wales
https://www.cardiff.ac.uk/conferences/sioe-conference

27-29 April – **7th Surfaces, Interfaces and Coatings Technologies (SICT)**, Barcelona, Spain (hybrid)
https://www.setcor.org/conferences/SICT-2022

May

7-11 May - **European Workshop on Modern Developments and Applications in Microbeam Analysis (EMAS)**, Krakow, Poland
https://www.microbeamanalysis.eu

8-12 May – **Materials Research Society Spring Meeting,** Honolulu, Hawai'i, USA (in-person)
https://www.mrs.org/meetings-events/spring-meetings-exhibits/2022-mrs-spring-meeting

23-25 May – **Materials Research Society Spring Meeting**, Honolulu, Hawai'i, USA (online)
https://www.mrs.org/meetings-events/spring-meetings-exhibits/2022-mrs-spring-meeting

22-26 May - **15th Conference on COmputer Simulation of IRradiation Effects in Solids (COSIRES)**, Porquerolles, France
https://sites.google.com/view/COSIRES2020/

22-27 May – **48th International Conference on Metallurgical Coatings & Thin Films (ICMCTF)**, San Diego, California, USA
https://icmctf2022.avs.org/

23-27 May - **IAEA International Conference on Accelerators for Research and Sustainable Development**, Vienna, Austria
https://www.iaea.org/events/accconf22

30 May – 3 June – **European Material Research Society Spring Meeting (eMRS)** (on-line)
https://www.european-mrs.com/meetings/2022-spring-meeting-0

31 May – 3 June - **65th International Conference on Electron, Ion and Photon Beam Technology and Nanofabrication (EIPBN 2022)**, New Orleans, USA - https://eipbn.org/

Upcoming conferences

June

02-04 June - **EPS Forum**, Paris, France - https://epsforum.org/

12-17 June - **13th International Particle Accelerator Conference (IPAC'22)**, Bangkok, Thailand - https://www.ipac22.org/

19-24 June – **29th International Conference on Atomic Collisions in Solids (ICACS) & 11th Swift Heavy Ions in Matter (SHIM)**, Helsinki, Finland - https://www2.helsinki.fi/en/conferences/icacs-shim-2020

27 June – 1st July - **15th International Conference on Heavy Ion Accelerator Technology (HIAT 2022)**, Darmstadt, Germany - https://indico.gsi.de/event/12135/

July

10-15 July – **22nd Ion Beam Modification of Materials (IBMM)**, Lisbon Portugal - www.ctn.tecnico.ulisboa.pt/IBMM-2022/

10-13 July - **FIT4NANO Workshop & Meeting,** Krakow, Poland https://www.fit4nano.eu (workshop information coming soon)

17-22 July – **14th European Conference on Accelerators in Applied Research and Technology (ECART)**, Sibiu, Romania – website coming soon

August

6-12 August – **11th International Conference on the Analysis of Geological & Environmental Materials (GeoAnalysis)**, Freiburg, Germany - https://geoanalysis2021.de/en/

21-26 August – **29th Condensed Matter Division General Conference (CMD29)**, Manchester, UK - http://cmd29.iopconfs.org/Home

29 August – 2 September - **35th European Conference on Surface Science, (ECOSS 35)**, Luxembourg - https://ecoss2020.uni.lu/

September

11-16 September - **IEEE International Conference on Nanomaterials: Applications & Properties (IEEE NAP-2022)**, Krakow, Poland - https://ieeenap.org/

11-16 September – **18th International Conference on Nuclear Microprobe Technology and Applications**, Lake Bled, Slovenia – website coming soon

11-16 September - **21st international conference on Radiation Effects in Insulators (REI-21)**, Fukuoka, Japan - http://rei21.kyushu-u.ac.jp/index.html

18-23 September – **23rd International Conference on Secondary Ion Mass Spectrometry (SIMS23)**, Minneapolis, USA - https://sims23.avs.org/

19-21 September - **European Material Research Society Fall Meeting (eMRS)**, Warsaw, Poland - https://www.european-mrs.com/meetings/2022-fall-meeting

22-24 September – **23rd Ion Implantation Science & Technology (with annealing) School**, San Diego, California, USA - https://www.mrs.org/iit2022/school

25-29 September - **23rd International Conference on Ion Implantation Technology (IIT)**, San Diego, California, USA - https://www.mrs.org/iit2022

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

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

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