# LISA BULLETIN

NEWS FOR THE LISA INNOVATIVE TRAINING NETWORK

AUGUST 2021, No 2

## Welcome to the 2nd LISA Newsletter!

As you will read here, the LISA project is proceeding well, with reports of scientific progress, specialized workshops, successful secondments and a greatly-anticipated transition towards in-person network-wide events.

Although not all LISA participants have yet had an opportunity to meet in one place, I believe that a real LISA community spirit has been developed nevertheless. This certainly contributed to the success of the first ever Hybrid live/remote training event organised and hosted by Mainz and GSI. Congratulations to the organisers and the participants on making this such a valuable and enjoyable workshop.

One week prior to the Mainz training, Mustapha Laatiaoui (GSI) and Sebastian Raeder (GSI) held an excellent Virtual workshop on the "Atomic Structure of Actinides & Related Topics".

https://indico.him.uni-mainz.de/event/78/

This was perfectly timed to provide a solid base of knowledge in this field for all LISA ESRs and affiliates. It was informative and inspirational to catch up on the state-of-the-art in actinide science in terms of the experimental methods, theoretical tools and understanding, and the ambitions for the future..

The LISA ESRs and affiliates themselves played a key role in this: excellent presentations were provided by Raphael, Andrea, Jake, Jessica, Arno, Jekabs, Steven, Martijn and Elisabeth.. Looking forward to many more LISA contributions at international events in the near future...

Bruce Marsh (LISA Coordinator)

Newsletter's coordination & edition:

Helena Escudero
ESR 13

Mitzi Urquiza
ESR 15

For any comment or request feel free to contact us here.

Beneficiaries:

Partners:

LISA – Laser Ionization and Spectroscopy of Ac-tinides. This Marie Sklodowska-Curie Action (MSCA)Innovative Training Networks (ITN) receives funding from the European Union's H2020 Framework Pro-gramme under grant agreement no. 861198.

# Research news

## Towards a reliable 225-Ac production

by Jake Johnson (ESR 01)

Clinical oncologists have long wished for a tool to target and kill tiny clusters of cancer cells that have spread around the body. Now, advances in targeted alpha therapy (TAT) are slowly precipitating this stuff of dreams into reality. The idea is simple: an alpha-emitting isotope is delivered to the malignant cells by a molecule that has an affinity for these cells only. The emitted alpha particles, are then fired off at around 5% the speed of light (100,000 times the speed of a bullet) and are stopped within only a few cell diameters (the width of a human hair), where the targeted damage is done. In practice, getting one's hands on the appropriate alpha-emitter is a challenge: they irksomely do not exist in nature, and must be synthesized through nuclear processes.

Within the LISA Network, we are looking into the production and extraction of one of these rare isotopes, and the only actinide candidate for TAT: Ac-225. To extract pure Ac-225 following its production in a proton-irradiated target, we use the Isotope Separation On-Line (ISOL) technique. It is the same method that is used at ISOLDE to extract exotic nuclei mere milliseconds after their production, but tailored towards collecting as much of the 10-day half-life Ac-225 as possible over a period of a couple of days.

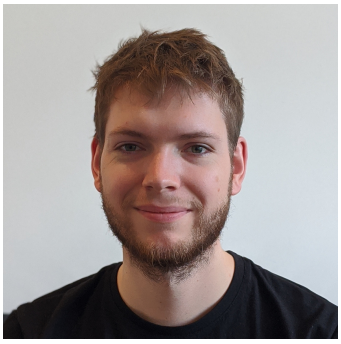
At the end of 2020, we benchmarked the efficiency of our method by extracting two samples from a known quantity of pure Ac-225 under different conditions. One result of our study found that around 10% of the initial amount of Ac-225 could be recovered when vaporized, laser ionized and mass separated in ideal circumstances. This was supplemented by the observation that a higher temperature of 2400 °C was required in more realistic circumstances, as some of the would-be Ac vapor was locked up into a refractory compound $Ac_2O_3$ in the target.

The results put a promising upper bound on how much atomic Ac-225 can be extracted by the ISOL method using our current lasers. But perhaps molecular extraction, and more powerful lasers could increase this bound even higher, to supplement the ongoing global efforts towards optimizing reliable Ac-225 production.

# Fellows activities

## Ti:sapphire Laser Workshop (ONLINE)

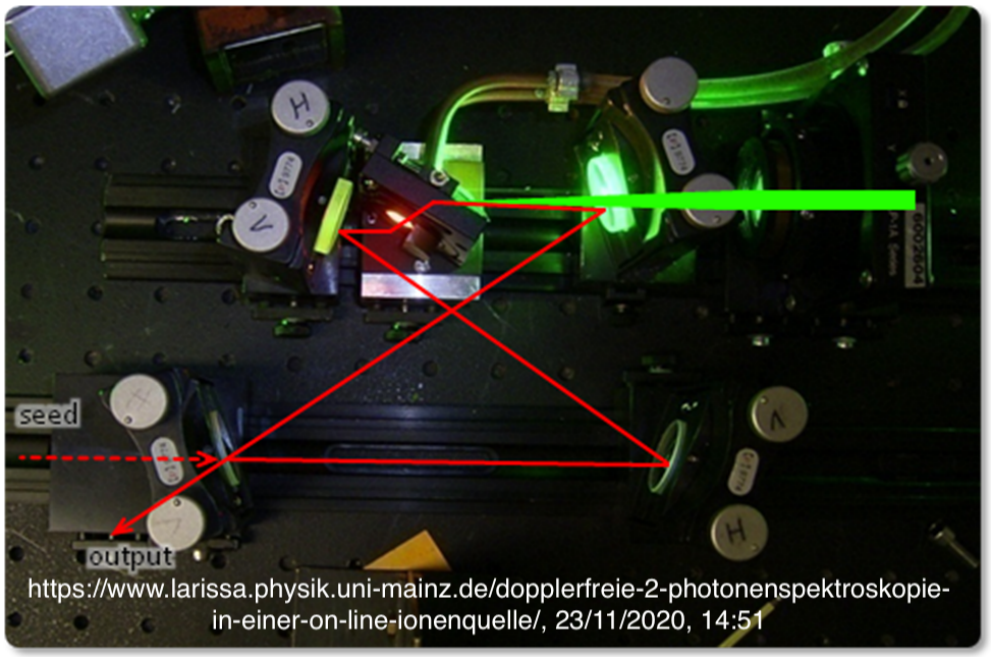
by Julius Wessolek (ESR 09)



On March 3rd 2021, a half-day Zoom workshop was held to kick-start the development of an injection locked Ti:sapphire amplifier, the project of Julius (ESR 9) at M Squared. This was done to gather and ideas and to establish and encourage knowledge transfer between the different groups affiliated and interested in this project.

After a brief introduction by James Bain of M Squared, Klaus Wendt (Mainz University) gave a presentation on the history Ti:sapphire-based high resolution spectroscopy with high repetition rates and Dominik Studer (Mainz University) talked about recent developments of the high power z-cavities, focussing on the measurement of thermal lens effects in the Ti:sapphire crystal. Volker Sonnenschein (Nagoya University) presented the updated injection-locked Ti:sapphire amplifier to be installed at RIKEN as well as new developments in direct diode-pumping of a CW-Ti:sapphire laser. To close, Mikael Reponen gave an update on developments at the accelerator lab at Jyväskylä.

I want to thank the speakers and the almost 40 people who for the interesting talks and the fruitful discussions they sparked.



## LISA Specialized Training 2 @Johannes Gutenberg University & Helmholtz Institute Mainz (Hybrid)

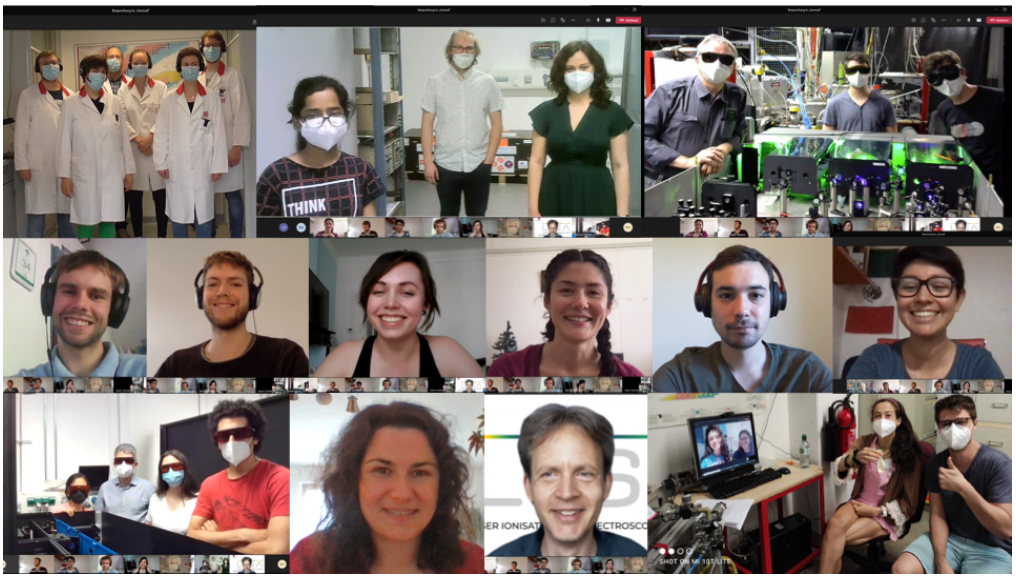
by Magdalena Kaja (ESR 05)

Nuclear chemical techniques and laser resonance ionization laboratory training was, due to the COVID restrictions, a hybrid event. Finally, for the first time, some of the ESRs could meet in person.

During the first day of the training, participants learn about Actinides from Christoph Düllmann and Ultra Trace Determination of Minor Actinides by Laser Mass Spectrometry from Klaus Wendt and Sebastian Raeder. The safety training was given by Christian Gorges. The final lecture was given by Mustapha Laatiaoui on the Investigation of atomic properties using ion mobility spectrometry.

During the next days students divided into small teams (2 on-site, 2 online) had to perform 6 different experiments: Np chemistry, n-activation of Ag, resonance ionization spectroscopy on Yb, mass spectrometric analysis of gases using the quadrupole mass filter, gas jet fluorescence, and quantum eraser & Sirah credo dye pulsed laser. All of the experiments were streamed to online fellows.

In the meantime, students visiting Mainz had an opportunity to see the TRIGA reactor and the cyclotron at JGU. During the training, two social events were organized. Participants divided into smaller groups had to compete with each other and solve the crime in the Shadow Hotel. The second event was the board game “Codenames”. Two sessions on soft skills also took place: PhD to Sciencepreneur by Falling walls and Science communication by Beate Hoerr. It was a very informative and exciting week. Thank you all for your participation!




*Perfect representation of the hybrid character of the training. All students were participating in the labs no matter where they were.*

## Secondment at Mainz

by Bianca Reich (ESR 02)

*Bianca Reich.*

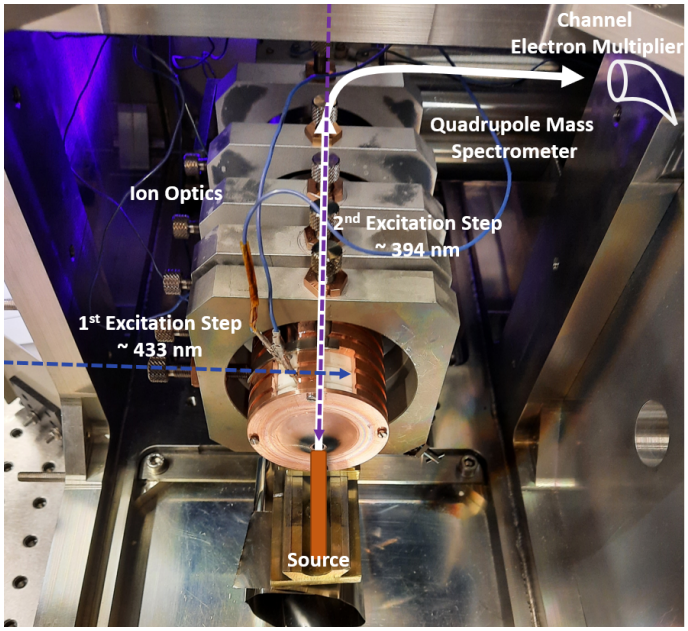
In November 2020, I started my two-month long secondment at the University of Mainz. I worked in the Larissa group together with Magdalena Kaja, ESR 05. The main goal was to get the Mainz Atomic Beam Unit (MABU) running again and do some spectroscopy on uranium and curium with it.

The MABU consists of an ion source, extraction electrodes, an electrostatic einzel lens, a beam deflector, a quadrupole mass spectrometer and a channel electron multiplier (CEM) for ion detection. The laser beam can be forwarded into the experimental setup colinear to the ion beam or perpendicular to it as shown in the figure (excitation of curium). For ion creation, the target material is pipetted onto zirconium foil and placed inside a tube source which is heated up to 2000°C. Ions are released from the source and guided into the ion optical elements by extraction electrodes, where the beam is shaped and focused. Afterwards the beam is deflected by 90 degree into a quadrupole mass spectrometer filtering the desired ions which will be detected thereafter by an adjacent CEM.

*Magdalena Kaja*

The excitation of the ions is performed by titanium-sapphire (Ti:Sa) lasers and takes place after the first extraction electrode for perpendicular excitation and inside the source for colinear excitation. In our experimental setup, uranium was excited colinear with a two-step ionisation scheme with equal wavelengths of 396.3 nm (Savina et al, ***New Resonance Ionization Mass Spectrometry Scheme for Improved Uranium Analysis***, Analytical Chemistry, 90 (2018) 10551-10558) for both steps. The first ionisation step for curium was done perpendicular to the ion beam with a wavelength of 433.0 nm and the second step was performed colinear with a wavelength of 393.5 nm (N. Kneip et al, ***Investigation of atomic structure of curium and re-determination of the first ionization potential,*** to be published soon) which can be seen in the picture down below.

Unfortunately, an ion signal for curium could not be found during the time of my secondment but at the beginning of 2021 after some relaxation of a lockdown caused by Covid-19.




*First ionisation step for curium, done perpendicular to the ion beam. Second step colinear to the ion beam.*

# Deliverables and Milestones

## Optimum filament setup for efficient Lr evaporation

by Jessica Warbinek (ESR 10)

Laser spectroscopy of the heaviest actinides is in many ways a challenging task. Only recently, the development of the RAdiation Detected Resonance Ionization Spectroscopy (RADRIS) allowed the first laser spectroscopic investigation of different nobelium isotopes at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt, Germany. This technique combines the collection and neutralization of recoil nuclei produced in fusion-evaporation reactions on a filament wire in a gas cell, followed by an efficient evaporation of these atoms by pulse heating the filament, laser ionization and eventually their detection. Turning to the heaviest actinide, lawrencium, demands the adaptation of the filament due to disadvantages of the tantalum filament type previously used for nobelium evaporation.

Heating the filament to high temperatures, as required for thermal desorption, can lead to the creation of background ions from surface ionization dependent on the temperature, the ionization potential of the atoms and the work function of the filament. Utilizing the same tantalum filament for lawrencium produces orders of magnitude elevated surface-ion backgrounds due to the lower ionization potential of lawrencium. Suitable filament materials should have low work functions, low desorption temperatures and high melting points for stability in long-term operation.

An off-line setup dedicated for filament tests was developed to study the desorption characteristics of different filament types with lutetium, the iso-electronic homologue element of lawrencium. With this setup, the relative fraction of surface ions as well as the desorption time constant can be examined on their temperature dependence for different filament configurations.

Studying different refractory metals and coatings, hafnium was proven to be the best choice with a sufficient longevity. Surface-ion contributions are suppressed by at least an order of magnitude compared to previously used tantalum filaments. A strong mechanical deformation of a thin hafnium-wire filament when applying the necessary desorption temperature for the RADRIS cycle was prevented, when 1 mm broad hafnium-strip filaments cut from hafnium foil were used.

Only recently, the first on-line tests on the desorption of lawrencium from this filament type have shown an efficient desorption of this heaviest actinide as well as an adequate stability for laser spectroscopic investigations on lawrencium. Thus, a thin hafnium-strip filament suitable for the desorption of lutetium with a low surface ion background enables on-line laser spectroscopy of lawrencium applying the RADRIS technique for the search of first experimentally determined atomic levels.

Different filament materials and geometries have been compared in a dedicated off-line test setup with respect to their desorption characteristics for the lighter homologue lutetium for the RADRIS technique. Desorption times, temperatures and the creation of surface-ion background have been studied dependent on the filament material and the operation temperature.

An off-line setup dedicated for filament tests was developed to study the desorption characteristics of different filament types with lutetium, the iso-electronic homologue element of lawrencium. A lutetium vapor source serves for coating of the test filaments. Atoms evaporated from the filament are then resonantly ionized by a two-step laser excitation scheme and guided towards a detection chamber. With this setup, the relative fraction of surface ions as well as the desorption time constant can be examined on their temperature dependence for different filament configurations.

# Interview: ESR 03 Mia & ESR 08 Anjali

***Mia Au***

*ESR 03 @CERN, Switzerland.*

**First of all, can you present yourself in a few sentences?**

I'm Mia Au, and I was born and raised in Edmonton, Alberta, Canada, where I did an undergraduate degree in mechanical engineering. I worked and finished my Masters in Engineering Physics at TRIUMF in Vancouver, where I entered the field of isotope production targets. Now, I'm ESR number 3 of the LISA network, living in Geneva and working at CERN.

**What motivated you to join the LISA project?**

For me, target developments for isotope production reach an ideal balance between engineering and physics. The availability of isotopes to be studied is one of the factors limiting science at ISOL facilities such as TRIUMF and ISOLDE, so I find working on isotope production very fulfilling. I love the multidisciplinary nature of the field and the problems that have to be solved. The LISA project presents the exciting challenge of producing and delivering actinides.

**What is your task in the LISA project?**

My project is to extract radiogenic actinide elements from ISOL targets at CERN and deliver the isotope beams to users. To do this, I study and optimize the conditions required to create volatile species of refractory elements in general and actinides in particular, using molecular extraction and resonant laser ionization. There is significant interest in studying actinides as both atomic and molecular species, so I also study molecular formation and dissociation of the molecules. I hope my work with molecular beams and target developments will provide opportunities for new discoveries with the actinide elements.

**How did you find your work after almost one year?**

I have learned so much in my first year in the project. I have been working on a few offline projects with molecular beams, including molecular extraction of beryllium and development of lanthanum fluoride beams. I worked for several months on the MIRACLS Proof-of-Principle Multi-Reflection Time-of-Flight (MR-ToF) mass separator on a project to do photodetachment studies of negative ions using collinear laser spectroscopy in an MR-ToF.

My online work has been focused on the actinides. Several ISOLDE targets that were irradiated and used in 2018 before the long shutdown were recovered and stored, keeping their long-lived activity. This year, I used these pre-irradiated targets to study long-lived species in the commissioning period before ISOLDE came back online. I got to learn from and work with the ISOLDE RILIS (Resonance Ionization Laser Ion Source) to study extraction and laser-ionization of actinide species, a topic closely related to the project of Bianca Reich, ESR 2. I've also been getting ready for another beam time coming up this year in July, dedicated to extraction of actinides for the LISA project. I've really been learning a lot, enjoying the research so far, and having fun! I am definitely looking forward to what the rest of the project will bring.

**Can you tell us about your hobbies apart from physics? How are you finding your new country of residence? What are you looking forward to after the COVID restrictions are over?**

Besides research, I really like to stay active. Normally, I enjoy playing soccer (football), running, hiking, climbing, doing yoga, snowboarding and skiing. I have been enjoying commuting to CERN by bike—on a clear day I get the view of the Jura mountains on one side, the Alps and Mont Blanc on the other. I also have fun painting and sketching, and I have always been a board game enthusiast. It sure has been strange moving to a new country during the pandemic. On the positive side, even simple things like going for a walk are different and exciting in a new place. I'm looking forward to rediscovering Geneva all over again as an entirely new city once the restrictions lift.

## *Anjali Ajayakumar*

*ESR 8 @GANIL, France.*

**First of all, can you present yourself in a few sentences?**

I am Anjali Ajayakumar and I am 26 years old. I was born and brought up in the southern part of India, Kerala. Currently, I am Early Stage Researcher 8 in the LISA ITN collaboration project with funding from MSCA EU H2020. My research studies are based on the topic, "In-Gas jet laser spectroscopy optimization for high resolution measurement of actinides "and I work at a heavy ion accelerator facility, GANIL (Grand Accélérateur National d'Ions Lourds), in Cean, France.

**How did you hear from LISA and why did you decide to apply for this position?**

During my final year of my masters, as an Erasmus student in the University of Gothenburg, Sweden, I was looking for opportunities to expand my knowledge and experience in the field of laser technologies and its applications. I came to know about LISA from my colleagues and supervisors from the University of Gothenburg. The research objectives, the trainings offered and collaboration of institutes doing high end research were perfect in terms of learning, research and career-development in the field I am interested in.

**How do you think your research could have an influence in the scientific community?**

There is a lack of knowledge about the nuclear and atomic properties in the heavier region of the nuclide chart. Gas jet coupled with a MHz resolution laser ion source will give better sensitivity and selectivity for the study of the short living isotopes in the heavy and super heavy regions with better precision. My contribution to the 'Development of a diode-pumped CW tunable Ti:sa lasers system 'amplified with an injection locked Ti:sa system can be of use to the science community by providing improved tuning range and high intensity laser pulses. This can be an alternative solution to the expensive traditional laser pumping technologies for a Ti:sa system. Reduced laser linewidth coupled with gas jet techniques can provide optical separation of isotopes and isomers for beam purification and trace analysis in RIB facilities.

**How did you find your work after almost one year? What is the thing you've liked the most?**

The initial stages of my doctoral studies include participation in offline commissioning of the laser setups at GISELE lab. It has been a great learning opportunity to work for S3-LEB (Super Separator Spectrometer-Low Energy Branch) project under construction which will implement IGLIS (In-Gas Laser Ionisation Spectroscopy) based technique. I am glad that I had access to the lab even during the crisis and train on several Ti:sa laser systems and the offline spectroscopy setup with the ABU (Atomic Beam Unit).

The research community at GANIL gives constant reviews, updating of all the ongoing works and milestones to achieve, motivating all the young researchers to progress which I found inspiring. Also, the LISA community with workshops, trainings and secondment opportunities helps young researchers like us to expand our research capabilities, skills and gives us a wider exposure to the scientific community.

**Can you tell us about your hobbies apart from physics? How are you finding your new country of residence? Do you like the food, weather, people, leisure activities there? What are you looking forward to after the COVID restrictions are over?**

During my free time, I like to explore new places. Especially, hiking and long walks are refreshing. Normandy region of France apart from its history and the majestic Mont Saint Michel, is stunning with its extended coastlines, hills and dales, and its beautiful country sides. The weather is usually humid, mostly rainy but that doesn't hinder the people from enjoying their day. Also, I enjoy the numerous varieties of French delicacies and their origin.

Once the Covid restrictions are over, I would like to visit the museums and the memorial which are closed due to the pandemic. I would also like to enjoy good food and spend quality time with my colleagues and friends.

# Outreach

## Promoting LISA: ready to spread the word!

by Isabelle Fontaine

It has been very exciting to see LISA image anchoring into people's mind as its new promotional material were being used gradually over last months.
Thanks to the kind support of the CERN design team and EU Office support, the project has now established a clear signature and branding which we hope will help LISA getting a full recognition in the coming years.

As travel are finally getting easier, conferences and workshops organizing themselves onsite, we are looking forward in having LISA and its ESRs presenting their work and outcome expected. So that they have some marketing support in this matter, several promotional materials have been created.

Jake Johnson (ESR 01) and the Training Office combined their creativity to come up with a foldable brochure (also to be used as a folder) presenting in more details the project and a roll-up poster (easily transportable) to give an overview of LISA key elements at various events or within departments.

Several headers (ie. newsletters, social media) just as templates (ie. presentation, letters, etc.) are now having a common design the network has gotten familiar with.

All the above documents can also be found under the "Communication" section of LISA Sharepoint/Workspace among other documents So if you also wish to find LISA signature or Business Cards design, make sure to check it out or contact me at Isabelle.fontaine@cern.ch should you have any questions.

As we are finalizing orders, beneficiaries will be receiving over the summer the materials ordered so that when ESRs will throw off the bowlines for outreach, they will be ready to spread the word!

*Brochure mock-up*


*Roll-up*


*Beach Flag*


*Business Cards*

# Upcoming events

| Event | Description | More information |
|---|---|---|
| Applied Nuclear Physics (ANP) conference promoted by the EPS Nuclear Physics Division.<br>  | The ANP conference will provide 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.<br>The ANP conference will offer an overview of the current state-of-the-art to young researchers and students, via numerous lectures presented by the leading scientists in a broad range of nuclear physics applications. | From 12 - 17 September at Prague, Czech Republic.<br>Early registration deadline: 30 July, 2021.<br>More information at: anpc2021. |
| Euroschool on Exotic Beams 2021<br>EUROSCHOOL ON EXOTIC BEAMS | The production and use of energetic radioactive beams is a rapidly developing new field in nuclear physics, especially in Europe. Pioneering experiments are taking place, dedicated facilities are in successful operation and new facilities are under construction Many workshops and conferences have been devoted to this new field and senior scientists have ample opportunities to be informed on the latest developments. Complementary to that and being an educative effort, the European summer schools on exotic beams have been devised so that Ph.D. students and young post-docs are introduced to this new area and receive fore-front and detailed information. | From 13 - 17 September 2021 (Online).<br>Poster submission deadline 31 July 2021.<br>Deadline for **online participants registration** 31 Jul 2021.<br>More info at: indico here. |
| Virtual DPG-Tagung (DPG Meeting) of the Atomic, Molecular, Plasma Physics and Quantum Optics Section (SAMOP).<br>DPG | The conference, organised with the support of the Technical University Kaiserslautern, is jointly run by the SAMOP divisions Atomic Physics (A), Mass Spectrometry (MS), Molecular Physics (MO), Quantumoptics and Photonics (Q) and the newly founded division Quantum Information (QI), as well as the working group “Young DPG” (AKjDPG). | From 20 - 24 September 2021.<br>Deadline for online abstract submission for poster/contributed talks 22 July 2021, 23:59 CEST<br>Deadline for **participants registration** 23 August 2021 (early-bird-fee) and 17 September 2021 (regular fee).<br>More information at: SAMOP21. |

| Event | Description | More information |
|---|---|---|
| 19th International Conference on Ion Sources – ICIS'21   | Whilst details are still being developed and finalised, TRIUMF will host a Zoom-based multi-day program over the week. For poster sessions and the coffee breaks, we will create a virtual space in Gathertown to meet and discuss. The scientific program of the virtual ICIS'21 will offer plenary sessions of invited and contributed oral presentations and two Poster sessions will be arranged as well. The scientific program will cover themes of the ion sources science and technology that are relevant to the production of ion beams for scientific research and for applications. | From 20 - 24 September, 2021. Online format.<br><br>Early registration ends on August 19, 2021.<br><br>More information at the ICIS2021 Webpage and indico. |
| LISA Specialized Training 3 | Advanced Techniques for the Production and Study of Actinides . | From 12 - 18 October, 2021, at Jyväskylä.<br><br>More information to be announced. |

KU Leuven is currently recruits 3 new PhD students in high-resolution laser spectroscopy. Share the word to possible candidates! Recruitment will be ongoing continuously through the summer until all positions are filled!
More info at KU Leuven Jobsite.

Newsletter's coordination & edition:

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LISA – Laser Ionization and Spectroscopy of Ac-tinides. This Marie Sklodowska-Curie Action (MSCA)Innovative Training Networks (ITN) receives funding from the European Union's H2020 Framework Pro-gramme under grant agreement no. 861198.

For any comment, request or suggestion, feel free to contact us here.