NEWSLETTER 18 | DECEMBER 2019

Röntgen Ångström Cluster

EUROPEAN SPALLATION SOURCE (ESS)

EDITORIAL

While construction of the European Spallation Source (ESS) in the Swedish city of Lund is well underway, another research infrastructure, which is a central pillar of the Röntgen-Ångström-Cluster (RÅC), is celebrating its 10th birthday this year. We are, of course, talking about the European XFEL near Hamburg. In November 2009, representatives of the ten participating countries had come together in Hamburg City Hall to lay the foundation for the international research facility with the largest X-ray laser in the world at its center.

Since these days, a lot has happened in the outskirt of Schenefeld: The European XFEL has added to the reputation of Hamburg as a metropolis for excellence in science and innovation. The unique capabilities of the European XFEL allows researchers to peer deep into the structure of cells, viruses or proteins – and gain new insights into their behavior. This, in turn, will help improve our understanding of certain diseases which is vital for the development of new and effective medication.

At the celebration of its 10th Birthday, high ranking representatives emphasized the European XFELs role to attract and bring together experts from different fields and countries to the region. Today, the research facility is home to more than 400 researchers, from around the world. We wish the European XFEL many more successful years to come. As always, our newsletter will keep you informed about everything that's happening in the RÅC-cosmos. Enjoy the read.

The Editors.

NEWS FROM LUND

Handover of the Long Instrument Hall

ESS celebrated an important scientific milestone, the official handover of the Long Instrument Hall from construction partner, Skanska.

Kurt Clausen, Vice-Chair of the ESS Council, John Womersley, ESS Director General, Andreas Schreyer, ESS Director for Science, and Per Smidfelt, Skanska Project Director, together with over 200 scientists and engineers involved in the design and construction of ESS's world-leading instruments, took part in the handover ceremony of the experimental hall, which is an important step towards instrument installations.

“The handover of the Long Instrument Hall is an important milestone on the path to delivering first science at ESS in 2023,” said John Womersley, ESS Director General. “We have moved from construction of the building to the first installations of scientific equipment, working closely with our partners in the member countries who are constructing most of this instrumentation.

“Together we are strongly determined to make ESS a landmark of European science.” The fifteen scientific instruments included in the ESS construction project, each unique and optimised to obtain specific kinds of data, are distributed over three experimental halls in the research facility. The experimental hall now handed over from Skanska will house eight instruments, which are more than 160 meters long. These instruments need to be placed at a distance from the target station in order to achieve a high level of detail in

NEWS FROM LUND

the research results, for example, an atomic resolution of a protein structure. The instruments are specialised in different kinds of experiments in order to support a range of research areas, such as biological molecules, fuel cells, battery research, or new computing materials. “Together with our in-kind partners throughout Europe, we are committed to delivering 15 neutron instruments that will enable outstanding scientific results,” said Andreas Schreyer, ESS Director for Science. “We have been working on the ESS instrument suite for many years, and several years of hard work lie ahead of us before completion, but this is a huge leap forward.” The instruments to be housed in the hall are BEER, BIFROST, CSPEC, HEIMDAL, MAGiC, MIRACLES, NMW and T-REX.

Participants at the handover ceremony form the layout of the instrument suite inside the Long Instrument Hall
photo: Roger Eriksson / ESS

„Scientists will interfere“ DESY launches dialogue in Hamburg

“We will be more decisive,” promised DESY Director Helmut Dosch on Monday evening at the panel discussion „Freedom of Science in Danger!” DESY invited high-ranking representatives from politics and science to debate and identify the global challenges science is facing in the world today.

“Fake news and populism, the fear of espionage and assassinations, political isolation - the current developments on the political world map have a devastating impact on the global network of science”, physicist and TV presenter Ranga Yogeshwar summarizes the situation. DESY Director Helmut Dosch calls for more self-criticism amongst researchers - in public and in politics: “It is also our task to make insights from research comprehensible. We will explain better and counteract scientific skeptics factually, but decidedly”. He also sent a clear message in the direction of politics: “We have to find an international basis for fact-based policies and prevent political intervention in research.” Dosch promises: “We scientists will interfere!”

There is consensus that shared values such as transparency must be maintained and that international cooperation must be intensified. Niels Annen, Minister of State at the German Foreign Office explained that cross-border cooperation is the only way forward, if we want to tackle the problems of an increasingly complex world.

MAX IV User Meeting-UM 19

The 31st “MAX IV User Meeting-UM 19” took place in Lund, Sweden, on 23-25 September 2019 with the goal to further develop MAX IV. At this annual event of MAX Lab the users of MAX IV share interesting research work utilizing the synchrotron X-ray techniques at MAX IV, covering condensed matter, structural biology, electron materials, metal processing, geology, archaeology, cultural heritage, and more.

Since 1988, the MAX IV user community has been actively engaged to form the annual user meeting contents and format to create a valuable and interesting MAX IV user meeting, by facilitating participants, the opportunity to discuss, learn and contribute towards the best use of MAX IV.

With 11 beamlines receiving light simultaneously and the current open call for proposal, including 4 beamlines open to external users for the first time, the team states that again it becomes important to gather/reunite the existing communities – within and across different fields – that will continue to benefit from MAX IV as well as contribute to drive and promote future new scientific opportunities.

Coordinated call

The submitted applications will be jointly evaluated at the end of January 2020.

PROJECTS

Prof. Dr. John Banhart *(German PI)*

Dr. Francisco Garcia-Moreno *(Responsible scientist)*

MSc. Mike Noak *(PhD student)*

UNDERSTANDING THE DYNAMICS OF METALLIC FOAMS AND GRANULAR MATTER USING SUBMICROSECOND SINGLE SHOT MULTI-PROJECTION X-RAY IMAGING

Many natural and industrial material processes occur over very short time periods, but our ability to capture them with existing imaging approaches is limited by current technologies. Fast sub-millisecond imaging in two dimensions (2D), e.g., optical or with x-rays, can be performed with current detector technologies and light sources. However, our ability to capture processes as they occur in three dimensions (3D) is limited due to both practical and technological challenges such as the spinning speed of a sample in standard tomographic acquisition schemes or the photon statistics for short exposure times. Within this project we will establish a methodology to reveal the full dynamic behaviour of matter with micrometre spatial resolution and high confidence in interpretation arising from a better volumetric insight into the matter. Temporal sampling down to 220 ns and extremely short exposure times (<100 fs) will allow recording of individual realisations (snapshots) of stochastic processes. The unique approach of splitting and recombining the x-ray beams will allow imaging simultaneously in different spatial orientations without rotating the sample. We will use these new dynamic, 3D imaging capabilities to investigate previously inaccessible mechanisms in foams and granular media, two material types of great interest in many industrial as well as natural processes. For the former we will be able to investigate in real-time foaming and gas nucleation and subsequent collapse of bubbles during liquid foam evolution.

Using the method we are proposing, it will be possible to record multiple angular views of samples allowing 3D information to be obtained all within a single shot (using single pulse illumination). The two light sources of extraordinary brilliance (MAX IV and European XFEL) are the obvious sites to host the first steps in the development of the ultra-fast single shot multidimensional imaging concept. At MAX IV we will be able to push synchrotron-imaging in 3D to new speeds (millisecond), without high-speed sample rotation. Implementation of the approach at European XFEL will enable unprecedented 3D imaging, with sampling down to 220 ns, opening up new avenues for research that were previously unimaginable. Although XFEL's have been constructed with the vision to probe ultra-fast processes (in the fs range) with atomic resolutions, in this project we propose to expand its capabilities to study dynamics in samples in the microscopic scale. This novel tool will be able to address unsolved scientific questions, including: i) the dynamics induced by high speed projectiles (velocities ≤ 4.5 km/s) like space debris hitting solar panels, ii) fluid dynamics such as fuel injection or dynamics in metallic foams, iii) fast biomechanical processes, such as fly and bite forces, and iv) temporal mechanical properties of novel materials like composite materials under applied mechanical stress/strain.

Based on the technical developments above, we will study:

- **Rupture mechanism of the foams:** we wish to obtain 3D images of rupture events in liquid metal foams. We will vary the temperature and alloy composition in various experiments in order to relate the rupture dynamics to intrinsic melt properties such as viscosity and surface tension. Two perspectives are possible:

1. analysis of a volume containing various bubbles, detecting various ruptures and determining their dynamics, after which the resulting information is related to the size of the ruptured bubbles;
2. in-depth analysis of a single rupture, thereby clarifying the stages of rupture from the trigger to initial suspected cracking of the film over the acceleration of the liquid material towards an end position in an enlarged cell and finally the oscillations and final adjustment of the broken filaments combined with local topological rearrangements.

This will enable verification, quantification and further development of the existing ideas (largely derived from radiography) on how rupture takes place.

PROJECTS

- **Nucleation and growth of bubbles in early stages**: by foaming various materials (based on different alloys and gas generating blowing agents) at different heating rates we will create an initial distribution of bubbles which then further grow. We attempt to capture as many bubbles as possible, label them and track them in time individually. The individual growth rates will be compared and differences related to possible heterogeneities in blowing agent distribution identified. By modifying the processing parameters (of metal powder pressing) we can identify systems in which more equally distributed nuclei are formed that expand in a more equal way. A homogeneous distribution of bubbles is essential for good mechanical performance of the solid foams.

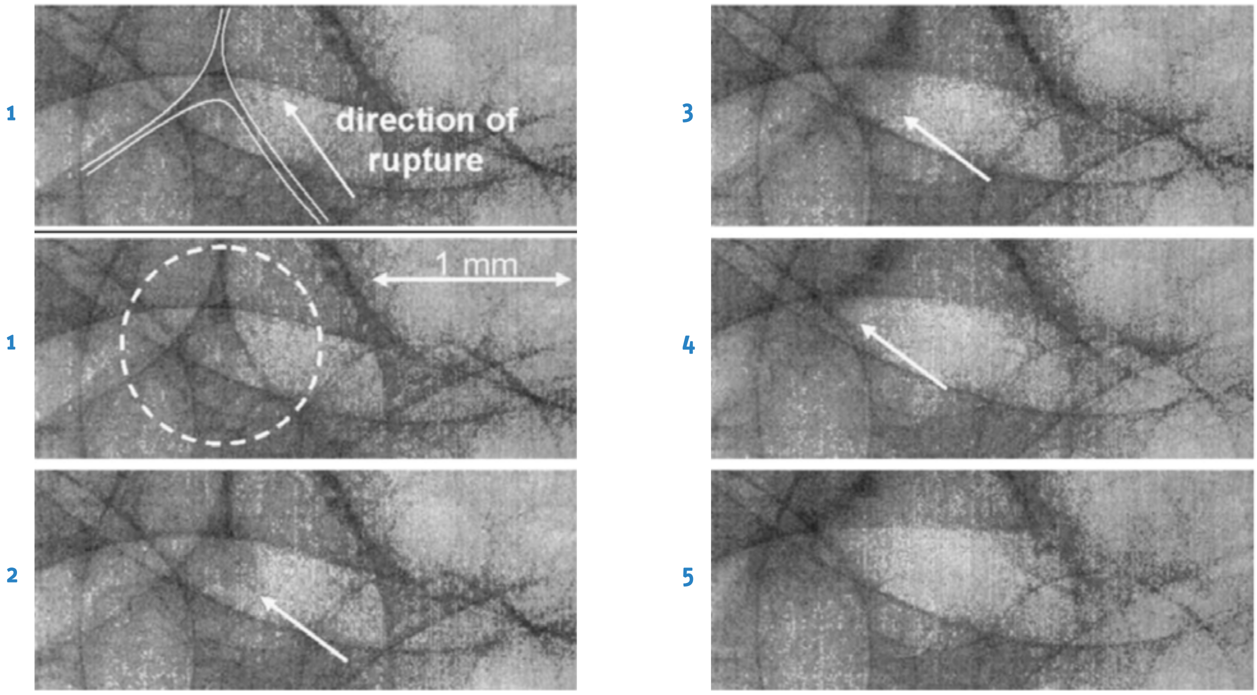


Fig. 1: Series of radiographies of a liquid metal foam featuring a rupturing film. Images are 200 m apart.* The lack of time resolution does not allow a proper analysis of the phenomena. * F. Garcia-Moreno, A. Rack, L. Helfen, T. Baumbach, S. Zabler, N. Babcsan, J. Banhart, T. Martin, C. Ponchut, M. Di Michiel, Fast processes in liquid metal foams investigated by high-speed synchrotron x-ray microradioscopy, Appl. Phys. Lett. 92 (2008) 3.

PEOPLE

The Röntgen-Ångström-Cluster is run by a Steering Committee consisting of German and Swedish representatives who are meeting at least twice a year to develop the strategy and progress of the collaboration. Here is a quick overview over the members in the delegations.

Representing the Swedish side

- Head of Delegation Lars Kloo, Secretary General Natural and Engineering Sciences, Swedish Research Council
- Björn Halleröd, Secretary General Research Infrastructures, Swedish Research Council
- Ulf Karlsson, KTH Royal Institute of Technology
- Kristina Edström, Uppsala University
- Stacey Sörensen, Lund University
- Co-opted member Aleksandar Matic, Chalmers University of Technology, Gothenburg

Representing the German side

- Head of Delegation Jürgen Kroseberg, Federal Ministry of Education and Research, BMBF, Bonn
- Helmut Dosch, Chairman of the DESY Board of Directors, Deutsches Elektronen-Synchrotron, Hamburg
- Götz Eckold, University of Göttingen - active member until October 31st
- Rolf Greve, Ministry for Science, Research and Equality, BWFG, Hamburg
- Lutz Kipp, President of the University of Kiel
- Jan Lüning, Scientific Managing Director, HZB Berlin
- Manfred Rößle, University of Technology, Lübeck

SCHOOLS

The RACIRI-participants , Photo: NRC Kurchatov Institute

Review of RACIRI-2019 Summer School at Svetlogorsk, Kaliningrad Region

In 2019, the 7th in the series of annual RACIRI Summer Schools took place from August 4–11 at the beautiful Baltic-Sea resort of Svetlogorsk, for the 3rd time already in the Russian Federation. While the general theme of the RACIRI School is “Advanced Materials Design at X-ray and Neutron Facilities”, each school can choose its specific topic, in case of RACIRI-2019 “Structure, Real-time Dynamics and Processes in Complex Systems”. The schools are organized by two bilateral platforms, the Swedish-German Röntgen-Ångström-Cluster (RÅC) and the German-Russian Ioffe-Röntgen-Institute (IRI), with the first school in August 2013 at Petergof/Sankt Petersburg, Russia.

At present, the most advanced research facilities, providing front-edge X-ray and neutron beams for scientific research and technical applications, exist or are under construction in countries around the Baltic Sea. They are located in Hamburg (PETRA III, PETRA IV, FLASH at DESY; and the European XFEL), in Lund (MAX IV; European Spallation Source ESS), in Gatchina/Sankt Petersburg (high-flux research reactor PIK), as well as the international research facilities Institut Laue-Langevin (ILL) and the European Synchrotron-Radiation Facility (ESRF), both in Grenoble/France. Both platforms share the same goal to ensure the best possible training to the next generation of researchers through RACIRI Summer Schools to ensure the optimal use of the state of the art research infrastructures at their disposal. This is – in brief - the main mission of the annual RACIRI Summer School.

At RACIRI-2019, 27 1-hour lectures were given to the 83 students: Participants were mostly doctoral students, master students in the final research phase of their studies, as well as several postdocs. Lectures were given by 27 expert scientists from the 3 organizing countries plus some from additional high profile research institutions. The students came from various fields, all using X-rays and/or neutrons for their research in basic and/or applied materials science, soft-matter and life science, as well as applications towards sustainable development. This interdisciplinary nature is a characteristic feature of the RACIRI Summer School.

To foster interactions between students and lecturers, each lecture day ended with one-hour Tutorials, where students and lecturers could casually discuss a wide range of topics surrounding the lectures or their own research work. Regular breaks during the lecture days, poster sessions in the evenings, a Science-Slam session, as well as a Cultural Evening directed by the students all helped to further improve the interaction among the students and with lecturers. Helpful for this was also a full-day excursion to the Curonian Spit and to Kaliningrad, including an organ concert in the old cathedral of the historically and culturally very important city of Immanuel Kant et al.

At RACIRI-2019, an overall of 83 students participated, with 37 from Russian, 8 from Swedish and 27 from German institutions. In addition there were 11 participants from other countries. They were all nominated by the three organizing countries from the group of applicants. At the end of the RACIRI summer school, the students were asked to submit feedback forms with a set of specific questions. They had a return-rate of 58%. In general, the assessment of various aspects of the RACIRI summer school by this feedback procedure was very positive, reflecting the status reached by RACIRI as the leading summer school for materials science at large-scale research facilities around the Baltic Sea.

For more information, visit www.rontgen-angstrom.eu and www.raciri.org.

Excursion to the Curonian Spit, Photo: Günter Kaindl

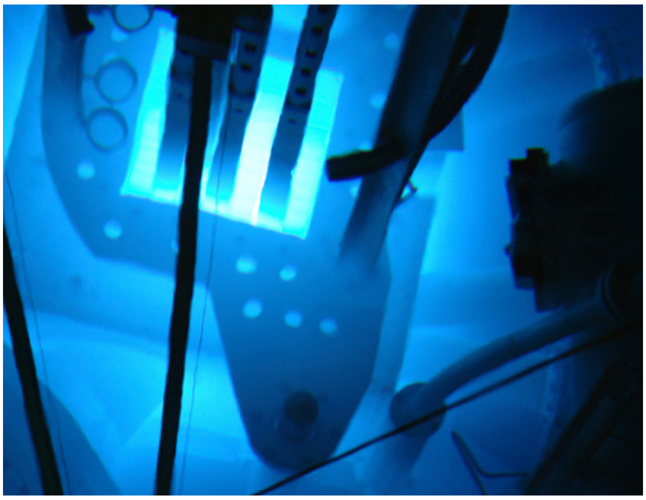
NEWS

An era comes to an end

One of the large scale facilities at the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB) will soon cease to exist: Having offered a complete set of continuously renewed instruments for neutron scattering and imaging with thermal as well as cold neutrons, the Berlin Experimental Reactor BER II will close its doors at the end of this year.

At the European Neutron Spallation Source (ESS), researchers will be able to use even more intense neutron radiation for their experiments in the future - and the Neutrons are produced without nuclear fission.

After the shutdown, BER II will be dismantled over the coming decades.



BER II reactor core, © HZB

THE OTHER NEWS

"No cash!" and "Cash only!"

Scandinavians often master their daily lives completely without using cash. In shops, for services or at recreational facilities: most cards are widely accepted and even the smartphone is widely used for payments. In stores or pubs the customer may very well be informed by a sign that "No Cash!" is accepted here. This stands in strong contrast to Germany, where one might easily come across a sign stating "Cash only!".

The majority of Germans therefore often have some cash in their pockets for smaller purchases of all sorts. However, things in Germany might slowly be moving in a different direction. Some trends indicate that, given the possibility of payment via cards, the Germans use this option more frequently from year to year. According to the retail research institute EHI, the cash share of retail sales in the previous year fell below the 50 percent mark for the first time in history.

In Swedish retail trade, on the other hand, only 30 percent of the transactions are cash-settled, as the domestic trade association reports. Some Swedish banks have even responded to the digital payments trend by ceasing to provide cash services in up to three quarters of their local branches. Whereas Sweden is already well on its way to a cashless society, Germany is still in its early stages, compared to some other nations. Time will tell if reservations towards cashless payments prevail in some parts of society, or if we will see mass adoption of modern payment solutions across all parts of society in the coming years.

Imprint
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