

## SNI2022: German Conference for Research with Synchrotron Radiation, Neutrons, and Ion Beams at Large-Scale Facilities

### SNI conference series

SNI2022 is the fifth meeting of the SNI conference series, bringing together the user communities of synchrotron radiation, neutron, nuclear probe and ion beam large-scale facilities. The series started in 2006 in Hamburg, and was followed by conferences in Berlin (2010), Bonn (2014), and Garching (2018). These conferences are organized every 4 years by the Committee for Research with Synchrotron Radiation (KFS, Komitee Forschung mit Synchrotronstrahlung), the Committee for Research with Neutrons (KFN, Komitee Forschung mit Neutronen), and the Committee for Research with Nuclear Probes and Ion Beams (KFSI, Komitee Forschung mit nuklearen Sonden und Ionenstrahlen).

The three committees bundle the user communities of condensed matter and gas-phase research at national and international large-scale facilities funded by the German government. These facilities are the light sources BESSY II (Berlin), PETRA III (Hamburg), and ESRF-EBS (Grenoble, France); the Free Electron Laser facilities FLASH (Hamburg) and European XFEL (Schenefeld); the neutron facilities MLZ (at the FRM II, Garching), ILL (Grenoble, France), and ESS (Lund, Sweden); and the nuclear probe and ion beam facilities at HZDR (Dresden-Rossendorf), GSI (Darmstadt), CERN (Geneva, Switzerland), and MLZ (Garching).

More than 400 researchers, primarily from Germany, but also from Europe and countries further abroad, gathered for the SNI2022 conference in Berlin, which took place at the Freie Universität Berlin from September 5 to 7, 2022. The participants' common denominator is their expertise and great interest in using advanced experimental techniques uniquely provided by large-scale research facilities. The research interests cover a broad variety of scientific fields, the goals encompassing everything from curiosity-driven investigations of fundamental principles to application-oriented development of materials and devices.

The SNI2022 conference therefore provided an overview of the breadth of scientific and technological areas as well as innovation and technology development to which research with synchrotron radiation, neutrons, and ion beams at large-scale facilities contributes. These facilities provide scientists from universities, research institutions, and industry with world-leading, and in many cases even world-wide unique experimental capabilities; for example, revealing the finest details of structural and functional properties, following their evolution in situ and during operation under relevant conditions, and resolving the dynamics of fundamental processes. Tailoring of

the facilities' instruments to specific needs has in many cases been made possible thanks to funding of the Federal Ministry of Education and Research (BMBF) within the ErUM framework (Investigation of the Universe and Matter), an internationally recognized tool fostering collaborations between university research groups and facilities.

#### Science for society

Highlighting the societal relevance of research performed at large-scale facilities was the central theme of SNI2022. The conference program, developed by the three committees (KFS, KFN, KFSI), included a suite of micro symposia, which were thematically focused on the societal challenges of our time, such as a carbon-neutral society, a sustainable energy system, an energy-efficient information technology, and global health issues - areas where research at large-scale facilities successfully contributes to finding urgently needed solutions.

These sessions were complemented by methodological sessions, dedicated to the discussion of current aspects of source, instrument, and technique development, as well as sample environments for in situ or operando studies. The major facility upgrade projects currently under development were presented, and participants pointed out the importance of these new facilities for staying at the forefront of science.

A key topic has been digitization and automation: from the source to the instrument, and from the measurement process itself to an online data analysis in real time. The potential of novel machine learning algorithms and, more generally, of AI-based approaches was intensively discussed in this context.

The presentation of the DAPHNE4NFDI project, recently funded within the National Research Data Infrastructure (NFDI) program of the German Research Foundation (DFG), received particular attention. The aim of this project is the development of federated data and software catalogs for photon and neutron experiments, which shall be realized by bringing together German university research groups with the operators of large-scale facilities. The DAPHNE4NFDI project will have a structuring effect on the communities. Correspondingly, the general overview as well as the presentations on specific activities within DAPHNE4NFDI sparked vivid discussions among the sessions' participants.

One micro symposium was dedicated to the discussion of the impact of large-scale facilities on industry, innovation, and transfer. The participants highlighted the relevance of advanced experimental techniques for industrial needs, presented best practices for facilitating industrial research, and discussed how transfer activities could be further developed.

#### Highlighting the complementarity

Plenary and keynote talks presenting research highlights from the different facilities completed the conference program. Judith Reindl (University of the Bundeswehr, München) presented on the applications of ion beams in radiobiology and radiation medicine. Maria Eugenia Toimil-Morales (GSI, Darmstadt) showed applications of ion track nanotechnology, ranging from filter production to highly sensitive biomimetic sensors and energy materials. Susan Schorr (HZB, Berlin) discussed the relevance of structural disorder for the performance of photovoltaic absorber materials. Mirijam Zobel (RWTH, Aachen) showed how X-ray and neutron-based techniques can be combined to probe interfacial structures and dynamics of nanoparticles. Beatriz Roldan Cuenya (FHI, Berlin) presented how in situ and operando X-ray spectroscopy and microscopy can be used to unveil the dynamic behavior of a catalyst.

Andrea Thorn (University of Hamburg) showed how structural biology research responded to the outbreak of the COVID19 pandemic. Ivan Zaluzhnyy (University of Tübingen) demonstrated how nano-focused X-ray beams can be employed for the investigation of mesocrystals. Finally, Ralf Röhlsberger (University of Jena and HI Jena) introduced quantum and nonlinear phenomena with X-rays, highlighting recent developments and presenting future research areas stimulated by this evolution.

A recurrent theme in many presentations has been the complementarity of the three types of probes -photons, neutrons, and ions- and how this can be exploited to obtain a better understanding of the subject of interest. This also underlined the general relevance of the SNI conference series, which brings together these user communities, and thus enables the exchange of knowledge, innovative ideas, and concepts beyond facility boundaries.

The benefit of combining different probes towards solving specific research goals was also highlighted by Frank Schreiber (University of Tübingen), current chair of the Committee for Research with Neutrons (KFN). His lively public lecture, entitled “Matter in the Light of Large-Scale Research Facilities: From Nanometers and Femtoseconds,” captivated the audience from the first to the last moment. Using examples of his own research field of soft matter science, Schreiber demonstrated the relevance of large-scale research facilities in addressing the pressing challenges of our time.

Finally, two poster sessions with more than 240 contributions were particularly well-received. After the restrictions of the past few years imposed by the COVID19 pandemic, the direct, personal exchange and discussion about the posters were greatly appreciated by the conference participants, making these sessions most memorable moments of the conference. SNI2022 was completed by a reception that took place in the evening of the second day of the conference in the Tipi am Kanzleramt, located right next to the German Chancellery in the heart of Berlin.

Award session and BESSY visit

The Committee for Research with Neutrons (KFN) traditionally bestows its prizes on the last day of the SNI conference. The Wolfram-Prandl Prize was awarded to Dr. Navid Qureshi from the Institute Laue-Langevin (ILL) in France for his achievements in the use of polarized neutrons to study complex magnetic phenomena. Dr. Artur Glavic from the Paul Scherrer Institute (PSI) in Switzerland received the new KFN Instrumentation Prize for his significant contribution to the development and construction of novel neutron reflectometers.

The prize ceremony also included the award of the best poster prizes. The recognition for the best poster was given to Justus Just (Max IV Laboratory, Sweden) for his poster entitled “Multimodal combined in-situ/operando XAS/XRD/UV-VIS measurements reveal complex transformation processes in energy materials.” Rebecca Spiecker (Karlsruhe Institute of Technology) received the second prize for her poster “Bragg magnifier optics for dose-efficient X-ray imaging with  $\mu\text{m}$ -resolution.” The third prize was given to Laura Guasco (MPI for Solid State Research, Stuttgart) for her poster “Kinetics of hydrogen absorption by in-situ neutron/X-ray reflectometry.”

Following the prize ceremony, many conference participants made use of the opportunity to visit the BESSY II facility in Berlin-Adlershof, including the Energy Materials In-Situ Laboratory (EMIL). The local organizers from the Helmholtz-Zentrum Berlin, together with the chairs of KFS, KFN, and KFSI, express their gratitude to all participants for their contributions, their vivid input, and their enthusiasm, all of which made SNI2022 a very successful and inspiring face-to-face meeting. We all look forward to SNI2026 and the opportunity to discuss the results of research at large-scale facilities during the four years to come, stimulated by the discussions we had across disciplines and experimental techniques at SNI2022. These inspiring conversations have laid the foundation for new ground-breaking science and technology-driven projects.

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