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The 11th International Conference on Biology and Synchrotron Radiation

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A report on the 11th International Conference on Biology and Synchrotron Radiation, which took place on 8–11 September 2013, in Hamburg, Germany, is presented.

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The 11th International Conference on Biology and Synchrotron Radiation (BSR) took place on 8–11 September 2013, in Hamburg, Germany (http://www.bsr2013.org). Since the first inaugural meeting in 1986 in Frascati, Italy, the BSR conferences initially took place biennially and, more recently, triennially. They provide a unique format that enables scientists and engineers from synchrotron and emerging free-electron laser (FEL) light facilities to meet with the researchers that use these facilities around the world. This synergy prompts an exchange of new ideas and concepts, and leads to concrete implications for a broad range of light-source-based applications in the life sciences. The international scope of these meetings is reflected in the choice of previous venues: four have taken place in Europe, two in North America, two in South America, two in Asia and one in Australia. Organization of the BSR meetings is a bottom-up community effort, which is supported by a standing International Advisory Committee. The preparation and budgeting of each meeting are the responsibility of the meeting organizers.

For the first time, this BSR conference was organized by a life-science-oriented research institute, the European Molecular Biology Laboratory (EMBL). Hosting it in Hamburg turned out to be very timely as it provided an opportunity for the attendees to visit emerging state-of-the-art infrastructures for the life sciences that use both synchrotron radiation and, in the future, FEL light on the campus of the German Synchrotron Research Center (DESY). In the opening lecture, Jochen Schneider, a previous Research Director of DESY, provided an insightful journey through the remarkable history of the site and the scientific achievements that have taken place there. The EMBL Unit in Hamburg has built and operated synchrotron radiation beamlines for structural biology applications on the DESY campus during the past four decades. The beamlines were initially constructed at the DORIS storage ring (closed in 2012), and since 2011 at the PETRA III storage ring, which has been converted into one of the most powerful dedicated synchrotron facilities to date. Despite its small size, EMBL Hamburg is one of the largest beamline facility providers for structural biology applications around the world.

The conference was attended by 330 participants, 78% (257) of whom came from European countries, followed by 10% (33) from Asia, 9% (30) from North America and 2% (7) from Australia. Two participants were from South America and one from Africa. The program of the meeting was organized into nine scientific sessions over three days, featuring 22 invited presentations. In contrast to some of the previous meetings there were no parallel sessions, in order to ensure scientific focus and good session attendance. A total of 213 abstracts were contributed by the registered participants, with most of them submitted to methods-dedicated sessions: 33% (70) to small-angle X-ray scattering (SAXS), 25% (54) to macromolecular X-ray crystallography (MX) and 15% (32) to X-ray imaging. Other popular sessions were structural biology hybrid methods with 10% (22), synchrotron instrumentation with 7% (15) and FELs with 5% (10) of the abstracts submitted. From these, 29 were selected for oral presentations and 182 were accepted as posters, which were presented during two dedicated sessions. About 60% of the conference attendees participated in the tour of the DESY synchrotron featuring, in particular, the new facilities at the high-brilliance PETRA III storage ring.

What were the specific emphases and key take-home messages from the conference? One of the main goals was to reflect the increasing complexity of life-science-oriented structural biology experiments, in which significant time and effort is spent in sample preparation. Specifically, molecular biology, protein purification, various forms of biophysical characterization, and crystallization are all essential initial steps in X-ray data collection experiments. In recognition of the importance of these procedures, one of the sessions was dedicated to the preparation of high-quality samples for

Figure 1
Photograph showing part of the conference venue in Hamburg.

synchrotron experiments. Imre Berger from EMBL Grenoble, France, discussed advanced co-expression tools for the production of highly purified complex protein assemblies for subsequent X-ray analyses. Susanne Gräslund from the University of Toronto, Canada, complemented this topic from the more high-throughput perspective of a structural genomics consortium. She described a toolset that they have accumulated over the past decade that has provided the consortium with more than 1000 X-ray structures of biological macromolecules to date.

Applications in the life sciences are key drivers of new technology developments in both existing and new synchrotron radiation facilities. Gwyndaf Evans from Diamond Light Source in the UK demonstrated how novel developments, exemplified by routine and automated micro-crystallography approaches, can be promoted by a dedicated life-science portfolio within the hosting facility. Marjolein Thunnissen from Lund University in Sweden impressively summarized a national master plan for building a brand new synchrotron, MAX IV. This facility will employ a newly developed multibend achromat approach to reduce the horizontal emittance by about one order of magnitude compared with the best existing machines, allowing diffraction-limited beam properties to be reached. This novel technology is also planned to be used in some of the most powerful machines around the globe, such as the European Synchrotron Radiation Facility (ESRF) in Grenoble, France, and the Advanced Photon Source (APS) at the Argonne National Laboratory, Illinois, USA.

Novel FEL facilities, namely those operating in the hard X-ray regime, have begun to have a strong impact on applications in the life sciences, which were previously thought to be beyond reachable limits. In a number of exciting presentations, insights were given into the present and future research opportunities created by the few X-ray FELs, either already in operation or under construction. Adrian Mancuso from DESY gave an overview on possible experiments at the future X-FEL on the campus, ranging from nanocrystal diffraction to single-molecule coherent-imaging experiments. Keith Hodgson from the Stanford Linear Accelerator Center (SLAC), California, USA, gave a passionate overview about present FEL experiments and future plans at the Linac Coherent Light Source (LCLS) in Stanford. Henry Chapman, also from DESY and who has pioneered various diffraction experiments using FEL light, recounted a number of recent impressive success stories and also explained how the expected dramatic increase of light pulse frequency at the future X-FEL in Hamburg could help to substantially increase the hit rate of samples injected into the beam, concurrently lowering the presently hard-to-reach requirements of sample quantity. Janos Hajdu from Uppsala University in Sweden complemented the survey of the field with their recent accomplishments using X-FEL mainly to study single particles, including large viruses.

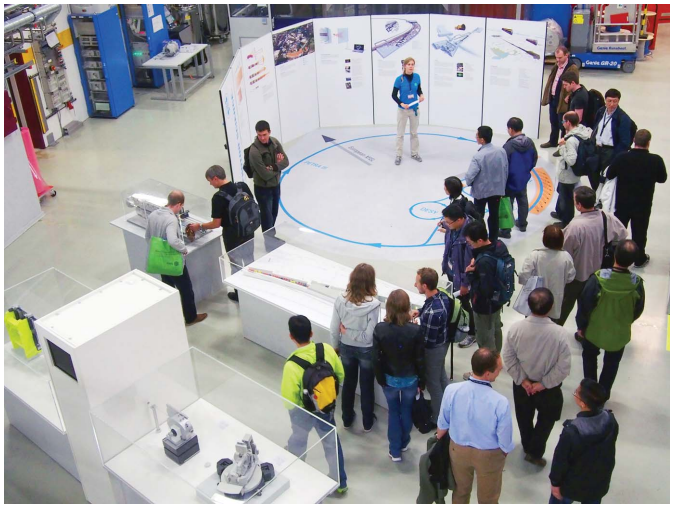

Figure 2
Photograph taken during the tour to the facilities showing the meeting participants listening to their guide explaining the different ring structures on DESY campus, sketched on the floor.

Of all the individual techniques, X-ray crystallography has had the strongest impact on structural biology over the past decades, as shown by various metrics. At the conference, the increasing need for combining complementary structural biology methods was well demonstrated. The session on hybrid approaches in structural biology has become a showcase for variable and innovative combinations. Six selected research talks included a particularly impressive lead presentation given by Junichi Takagi from Osaka University, Japan, who displayed structural insights into the higher-order architecture of the synaptic adhesion machinery by combining correlative microscopy techniques and X-ray crystallography. Most of the other presentations in the hybrid methods session also demonstrated how crystallographic data in combination with various complementary structural biology techniques could be employed in various challenging projects.

SAXS has become a key method in structural biology on its own and in combination with other approaches. A session dedicated to biological SAXS summarized recent developments around the world, with lead presentations by Clement Blanchet from EMBL Hamburg and Lois Pollack from the CHESS synchrotron at Cornell University, New York, USA. Clement emphasized that the major breakthrough in using SAXS to study biological samples has been achieved due to the high-brilliance set-ups and automation of the experiment and data handling coupled with novel data interpretation methods. Lois focused on advanced time-resolved SAXS experiments to structurally characterize the folding processes of RNA, which are difficult to capture by other structural biology approaches. The broad spectrum of possible SAXS applications was further underlined by the impressive number of submitted abstracts, some of which were presented across different sessions of the meeting.

Complementary to biological SAXS, which focuses on low-resolution structural information of biological macromolecules and complexes, X-ray imaging methods provide an opportunity to study various cells and organelles, and obtain data about their overall shapes and structural dynamics. Insights into this field were given by an intuitive lead presentation by Leann Tilley from the University of Melbourne, Australia, who presented her X-ray imaging investigations on the malaria parasite *Plasmodium falciparum*, in part using lens-less imaging techniques. In a second presentation, Lisa Miller from Brookhaven National Laboratory, New York, USA, focused on using synchrotron X-ray fluorescence microscopy and absorption spectroscopy to determine the pathological distribution of metal ions in the brains of patients suffering from Alzheimer's disease. In the context of a molecule-oriented structural biology community, represented by the overwhelming majority of meeting participants, imaging techniques still remain somewhat separate. Bridging the remaining resolution gaps to allow us to visualize at least some of the largest known molecular complexes could lead to tremendous synergies, and it remains to be seen what kind of progress can be achieved in this area in the coming years.

To obtain feedback about the scientific level of the conference and expectations of future meetings, we conducted an online questionnaire and received responses from about half of all participants. The results provided a picture of the expected future trends in the

fields of life-science research that make use of X-ray-based light sources. For instance, it was suggested that there should be more emphasis on emerging topics, notably on hybrid structural biology approaches (40% of respondents), FEL applications in biology (35%) and biological X-ray imaging and absorption (33%). It will be interesting to see whether these expectations will be matched by the development of new applications in the relevant fields. A natural opportunity for these to be showcased will be at the 12th International BSR conference in 2016 in Stanford, California, USA. The University of Stanford, which operates the Stanford Synchrotron Radiation Light source (SSRL) and the LCLS free-electron laser, in cooperation with Rutgers University, which is in charge of the Protein Data Bank (PDB), will host this meeting. There are three years ahead with expected further exciting developments in new emerging light sources, novel X-ray-based structural biology approaches coming on board and further integration of technical developments with the project-oriented needs of the scientific community. See you again in three years at Stanford!

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