The European X-ray Free Electron Laser: a tool for fundamental research and a wide range of applications

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X-ray free-electron lasers (XFELs) are the first light sources that are able to routinely generate coherent, ultra-brilliant, tunable laser pulses in the X-ray regime. The European XFEL (www.xfel.eu), is a world-leading large scale research facility, member of EIROforum (www.eiroforum.org), an intergovernamental association of eight of the leading European large-scale infrastructures. Thanks to a 1.7 km long, 17.5 GeV linear electron accelerator based on superconducting resonant cavities and the Self Amplified Spontaneous Emission (SASE) process taking place in very long undulator magnet arrays, high repetition rate ultrashort X-ray flashes with a brilliance that is a billion times higher than that of the best conventional synchrotron X-ray radiation sources are produced. The European XFEL is opening up areas of research from physics to structural biology that were previously inaccessible. Using the X-ray flashes of the European XFEL since the start of its operation in mid-2017, scientists from all over the world are able to map the atomic details of viruses, decipher the molecular composition of cells, take three-dimensional images of the nanoworld, film chemical reactions on the femtosecond time scale and study processes such as those occurring deep inside planets and in extreme conditions of temperature, pressure and applied magnetic field.

The European XFEL is becoming a very efficient decoder, obtaining in a much shorter time and with reduced effort many structures for molecules such as membrane proteins, from which crystals larger than a micrometer in size are hard to obtain. This will advance progress in our understanding of pathogens and the development of pharmaceutical remedies. In addition, biomolecules modify their structure while performing their respective tasks. It would be extremely illuminating to follow these modifications and see the motion of the moving parts in a movie. To make a film of a moving object, it is necessary to take many snapshots. Faster movement requires a shorter exposure time and a greater number of snapshots to avoid blurring the pictures. This is where the ultrashort duration of the FEL pulses will ensure sharp, non-blurred pictures of very fast processes. During the Covid-19 pandemic, XFEL was used to gain insights into protein shape and function at the micro- and nanoscale (SAXS curve). The results from this experiment could improve our understanding of the immune response to coronavirus and help to develop medical strategies to overcome COVID-19.

The European XFEL provides an opportunity to educate a new generation of scientists to address the frontiers of research in an open environment, promoting the European dimension of knowledge and its international mobility. The European XFEL is located in the metropolitan area of Hamburg, Germany, and has a long-standing collaboration agreement with DESY for the accelerator operation. It is organized as a non-profit company with limited liability under German private law (GmbH) that is publicly funded (total construction budget: 1.54 B€; operation budget for 2022: 141 M€) through its international shareholders from 12 European countries. The shareholders' assembly, the so-called Council, is the supreme organ of the European XFEL GmbH, which decides on all important issues of the company (like the annual financial statement and the annual operation budget) and important personnel matters as well as the further development of the facility. The Council meets at least three times a year and is led by a Chair and a Vice-Chair, who are elected from the Council delegations for a total of up to two terms, not exceeding two years each, and who, upon election, leave their delegations and become supra partes.

We note, that Federico Boscherini (in the photo) Professor of Physics at the Physics and Astronomy Department of the University of Bologna, has been elected as the new Chair of the XFEL Council. The appointment starts from July 2022 for a first two year period. ■

Eugenio Scapparone,
INFN Bologna Section director

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