

New scientific opportunities at the European X-ray Free Electron Laser

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In the past decade we have seen very important developments in the field of accelerator based X-ray user facilities, with the advent of 4th generation synchrotron sources and hard X-ray free electron lasers (XFEL). Among the latter, the European XFEL is the first hard XFEL powered by a superconducting linear accelerator, which enables MHz rate pulse generation, leading to an increase of more than 2 orders of magnitude in the number of delivered photon pulses per second to the sample.

A unique feature of X-ray FELs is the combination of the extremely short (fs) photon pulses with the short (Å) wavelengths of the produced x-rays. These new user facilities are opening novel avenues in the investigation of fundamental processes in many areas of science, from physics to chemistry, biology and materials science, because they allow investigation of matter at the time scales of electron and nuclear dynamics (down to fs), with chemical selectivity and bulk sensitivity.

The aim of this presentation is to provide to the CMD and FisMat scientific community a glimpse of the new research opportunities that are opening up at EuXFEL. I would also like to take this opportunity to establish a closer communication channel with groups who are interested in learning more about our present and future capabilities and how they match their expectations.

In the talk, I will briefly introduce the European XFEL facility and then report on a selection of scientific highlights in different areas of research. Applications address fundamental processes of light-matter interaction, ultra-fast dynamic processes in liquids and solids, investigation of electronic and structural properties and their dynamics in biomolecules, nanostructures, disordered materials and high energy density states of matter. Finally, I will comment on some important challenges ahead.