XVI International School and Symposium
on Synchrotron Radiation in Natural Science
Poland, 25-30 May 2025

An introduction to X-ray Science and hard X-ray Free Electron Lasers

T. Feurer[1]*

[1]*European X-Ray Free-Electron Laser Facility GmbH, 22869 Schenefeld, Germany*

*e-mail: thomas.feurer@xfel.eu

Hard X-ray Free Electron (XFEL) lasers produce extremely intense and ultra-short X-ray pulses, perfect for investigating the structure and dynamics of matter at atomic length and time scales. Operating for over a decade, these lasers have demonstrated a wide range of applications in physics, chemistry, materials science, and structural biology.

The European XFEL, one of the latest large-scale research infrastructures in Europe, recently celebrated five years of successful user operations. The facility features a 3.5 km long tunnel, including a 2 km long superconducting accelerator, stretching from DESY in Hamburg to Schenefeld in Schleswig-Holstein, where the experimental hall houses seven instruments. These instruments offer a broad range of experimental capabilities.

Since beginning operations, numerous exciting user experiments have been conducted in fields such as physics, chemistry, bio-crystallography, and material science. In my talk, I will present the main principles of the science performed at the European XFEL, with a focus on high energy density science and attosecond science. I will also provide examples from recent experiments in various scientific areas.

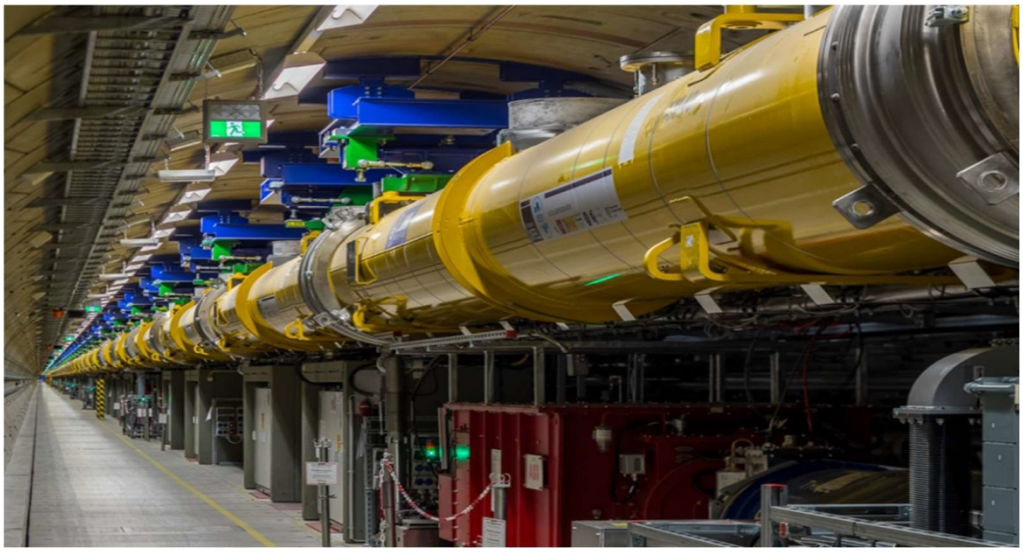

Figure 1. A glimpse of the 2 km long superconducting accelerator.