Blucher Physics Proceedings
Janeiro de 2015, Número 3, Volume 1

THE EUROPEAN X-RAY FREE-ELECTRON LASER (XFEL) PROJECT

Massimo Altarelli

European X-Ray Free-Electron Laser Facility, Germany

Synchrotron light sources have produced a revolution in X-ray science in the last decades. The remarkable progress in brilliance of storage ring sources is however attaining some basic physical limits, and further progress can only be at the cost of versatility and ease of operation.
There is at present a worldwide effort to implement free electron laser (FEL) X-ray sources, to produce spatially coherent, ultra-short (~ 10 fs) pulses with very high peak brilliance (in excess of 10^{28}-10^{32} photons /s/ mm^2/mrad^2/0.1% bandwidth). These sources overcome the intrinsic limits of brilliance imposed by the storage ring geometry, with a single-pass geometry, based on linear accelerators (linacs). The scientific case includes time-resolved studies of dynamics on sub-ps scales, structural studies by imaging of non-periodic systems, especially in structural biology, and investigation of high-energy density phenomena such as the phase diagram of warm dense matter and non-linear x-ray optics.
The ambitious scientific goals and the status of the European X-ray Free-Electron Laser project, under construction in Hamburg, Germany, aiming to attain the hard X-ray region, with wavelengths down to 0.05 nm, and with the high repetition rate allowed by the superconducting linac technology (27 000 pulses/s), are described in particular.