POLFEL – POLISH FREE ELECTRON LASER FROM THz TO XUV

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Free Electron Lasers (FEL) based on the effect of self-amplified spontaneous emission (SASE), break fundamental barriers that limit both usual optical lasers (in wavelength and tunability) and conventional synchrotron radiation sources (in coherence, pulse length and intensity). SASE-FELs can produce a monochromatic radiation in femtosecond pulses with a peak power up to several GW, in the wide spectral range from terahertz waves down to hard x-rays. Both the peak brilliance and a number of photons in the coherence volume exceeds that attainable with the best 3^{rd} generation synchrotron beamlines by up to nine orders of magnitude. The unique SASE-FEL radiation properties open up previously unavailable opportunities of probing the condensed matter with atomic spatial and femtosecond temporal resolution.

In recent years, the ideas of many pioneering research methods making use of these new, 4^{th} generation light sources, have been confirmed experimentally. The SASE-FELs have recently become indispensable complementary to the 3^{rd} generation synchrotrons, demonstrating their key importance in addressing the challenges of modern science and technology.

Currently operating in Europe are only three SASE-FEL facilities (working in the wavelength range of VUV and shorter): FLASH in Hamburg, SPARC in Frascati and FERMI at ELETTRA synchrotron in Trieste. Access to these devices is very limited, as compared to needs. Until 2016, only 3 or 4 new sources of this type will be built in Europe. In this number may be Polish free electron laser POLFEL, which construction in the coming years has been proposed. Apart from the SASE-FEL laser facility, POLFEL will also form a scientific center, focusing its activities on the development of experimental methods and operating electromagnetic radiation for basic research and technology purposes. It will be also involved in the development of new intense photon sources for technology and medicine. It is proposed to locate the facility at the National Centre for Nuclear Research in Świerk near Warsaw.

The lecture is aimed at the presentation of concept and applications of the Terahertz-FEL source which is proposed as the first stage of construction, thereafter, in the next steps, to be supplemented with XUV to soft x-rays emission capability.

The research capabilities of the powerful long-wavelength and tunable photon source, have been addressed to basic research in the wide range of disciplines: from medicine, biology, chemistry to atomic and high energy density physics and astrophysics. Proposed facility represents a unique tool for surface engineering and other processes which utilize the irradiation, as well as for substances identification for security-related applications.