

## **Science with UV/X-ray free electron lasers**

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While the most advanced synchrotron light sources are reaching the limit of their fundamental performances the fast growing field of sub-picosecond and subfemtosecond time resolved experiments is rising a strong demand for intense, coherent and ultrashort IR-hard x-ray radiation sources. Depending on the wavelength, ultrashort pulses can be produced, for example, by plasma sources, high harmonic generation by femtosecond coherent laser pulses or by free electron laser (FEL).

Development of FEL started when in 1970 J.M. Madey recognized that coherent electromagnetic radiation is generated and amplified by stimulated emission of bremsstrahlung, when relativistic electrons propagate co-linearly with the radiation field in a periodic magnet array or undulator. While other ultrashort radiation sources are suitable for specific applications the FEL would combine most of the behavior of both a laser and a synchrotron light source.

In this lecture will focus some of the most interesting application of very brilliant ultrashort and coherent radiation pulses. The emphasis will be given to those experiments where the main parameters to be considered are the magnitude of the e.m field magnitude, time structure of the radiation pulse, transversal and longitudinal coherence and state of polarization.