Press Release
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Towards gigawatt sub-femtosecond pulses in the water window

An international collaboration including a team lead by IPFN Professor Marta Fajardo demonstrated for the first time the implementation of chirped pulse amplification (CPA) at a free electron laser (FEL), which reduces significantly the pulse duration with the future potential to generate fully coherent gigawatt sub-femtosecond pulses in the water window.

CPA is a groundbreaking technique that influenced heavily the laser development since its invention. With CPA, it was possible to develop laser systems delivering pulses with durations of femtoseconds and energies per pulse large enough to reach a peak intensity of petawatt.

FELs produce laser-like radiation with the capability to reach shorter wavelength ranging from soft x-rays to hard x-rays. FELs play an important role in today's research ranging from physics and biology to material science and the temporal resolution, defined by the pulse duration, becomes crucial when studying ultra-fast dynamics. FELs seeded by an external laser deliver fully coherent pulses, however the pulse duration of the FEL is fundamentally limited by the gain-bandwidth.

In the published article, the researchers show that this limit can be overcome by applying the technique of CPA to a FEL. The experiment was carried out at the seeded FEL FERMI in Trieste (Italy), where the external seed pulse was stretched in time before seeding the FEL.

This allows increasing the bandwidth of the FEL pulses, which in return leads to a shorter FEL pulse duration. Since the spectral phase of the stretched external seed is transmitted to the FEL pulse a compressor, as in a traditional CPA laser system, is necessary to recover the shortest possible pulse.

The international team has demonstrated that the initial pulse duration of 90 femtoseconds was reduced to 50fs using CPA at the FEL tuned to a wavelength of 37nm.

This technique has the potential to create gigawatt sub-femtosecond pulses in the water window at FELs, which allows an unprecedented temporal resolution for imaging and pump-probe experiments.

For more information:
D. Gauthier et al., "Chirped pulse amplification in an extreme-ultraviolet free-electron laser", Nature Communications 7, 13688 (2016)

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