

Versatile optical laser will enable innovative experiments at atomic-scale measurements

December 12 2016

The European X-ray Free-Electron Laser ([XFEL](#)) facility, near Hamburg, Germany, was built with one objective—to provide pulses of light short enough, bright enough, and of small enough wavelength to observe processes that would otherwise be too fast and/or too infrequent to measure in real-time.

Without such ultrashort pulses—and this means millionths of billionths of a second long (femtoseconds)—measurements are limited to a before-and-after look at molecular interactions. Six different end-stations will be available for scientists from across the globe to conduct experiments using the XFEL beam once it is fully functioning in 2017.

In order to make these measurements, the research team developed a high-power, pulsed, [optical laser](#) that is synchronized with the XFEL pulses and tunable in both wavelength and pulse duration to accommodate the needs of each of the six different experiments being conducted. The features of this versatile optical [laser](#) system will be published in a paper in the journal *Optics Express*, from The Optical Society (OSA).

"The real uniqueness of our laser lies in the fact that it matches the burst emission pattern of the European XFEL," said Max J. Lederer, lead scientist, XFEL. "It therefore enables experiments at the highest possible pulse rate of the XFEL with optical pulse parameters (energy, pulse duration) only obtainable at low repetition rates from Ti:Sapphire systems."

These days, finding an optical laser capable of producing ultrashort pulses for research, such as a titanium-sapphire (Ti:Sapph) laser, isn't difficult. But finding such a laser that can match the power and timing specifications of the six XFEL experiments is difficult. "In other words, it's the high repetition rate and average power during the bursts that make the difference," Lederer said.

But why would a facility built to house one of the largest and most advanced lasers, need another laser? In fact, this additional [laser system](#) is an integral part of performing the projected atomic-scale measurements. The optical laser pulses serve to prepare samples, using the interaction with it as the first step, in some sense as a control, before using the x-ray pulse to probe and investigate the unknown dynamics. It is mainly the "pump" part of the pump-probe experiments the laser is designed to perform.

"The laser system is [built] to satisfy the need for an experimental optical pump-probe laser, synchronized and adapted to the emission pattern of the European XFEL. The laser will typically activate samples, followed by probing with the X-ray pulses," Lederer said.

The need for tunability of the pump laser comes from each of the six scientific stations housing different experiments that investigate various sample types and phases of matter. The optical laser provides this configurability via a number of optical techniques that harness light-matter interactions to result in the precise energy and timing of the pulses needed.

One example of such a process is called parametric conversion which refers to the conversion of one particle of light into two of half the energy, or vice versa. "For enhanced experimental flexibility, the spectral range from UV to THz will be made available through parametric conversion and THz-generation schemes," Lederer said.

Installation of the first laser has already begun and Lederer and his team look ahead to the exciting capabilities of the facility. Lederer said, "We are of course keen to meet the deadline to deliver the 'first photon' together with the XFEL. Personally, I'm keen on seeing the laser utilized in as many scientific discoveries as possible in the future."

More information: M. Pergament et al, Versatile optical laser system for experiments at the European X-ray free-electron laser facility, *Optics Express* (2016). [DOI: 10.1364/OE.24.029349](https://doi.org/10.1364/OE.24.029349)

Provided by Optical Society of America

Citation: Versatile optical laser will enable innovative experiments at atomic-scale measurements (2016, December 12) retrieved 26 April 2024 from <https://phys.org/news/2016-12-versatile-optical-laser-enable-atomic-scale.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.