CFEL SCIENCE

Colloquium

22nd November 2013 - 14:00

CFEL-bldg. 99, seminar rooms I, II, III

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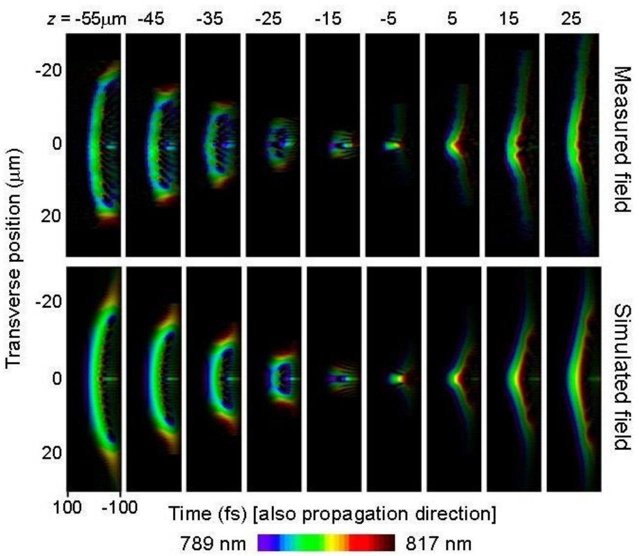
Measuring everything you've always wanted to know about a light pulse

The vast majority of the greatest scientific discoveries of all time have resulted directly from more powerful techniques for measuring light. Indeed, our most important source of information about our universe is light, and our ability to extract information from it is limited only by our ability to **measure** it.

Interestingly, the vast majority of light in our universe remains **immeasurable**, involving long pulses of relatively broadband light, necessarily involving ultrafast and extremely complex temporal variations in their intensity and phase. So we have been developing techniques for measuring, ever more completely, light with ever more complex submicron detail in space and ever more complex ultrafast variations in time. The problem is severely complicated by the fact that the timescales involved correspond to the shortest events ever created, and measuring an event in time seems to require a shorter one, which, by definition, doesn't exist!

Nevertheless, we have developed simple, elegant methods for completely measuring these events, yielding a light pulse's intensity and phase vs. time and space. One involves making an optical spectrogram of the pulse in a nonlinear optical medium and whose mathematics is equivalent to the two-dimensional phase-retrieval problem — a problem that's solvable only because the Fundamental Theorem of Algebra fails for polynomials of two variables. And we have recently developed simple methods for measuring the **complete spatio-temporal electric field** of an arbitrary light pulse.



Nine measured and simulated snapshots of an ultrashort laser pulse (seen from the side) as it propagates through a focus. Color indicates the instantaneous frequency of the pulse (i.e., the phase). The interesting submicron spatial and ultrafast temporal (and superluminal) structure results from diffraction of the beam at the edge of the focusing lens.

Host: Anne-Laure Calendron, Yi-Jen Chen, IMPRS