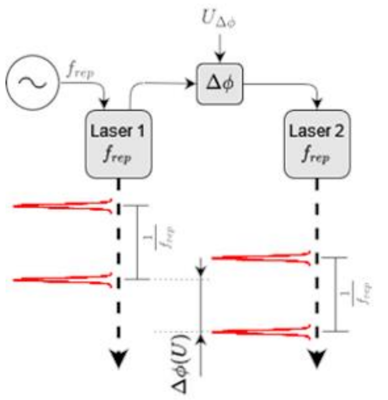
Improved "pump and probe" measurements

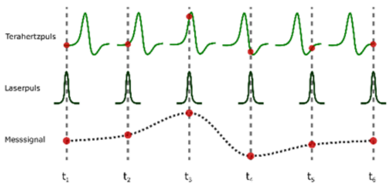
Dynamic voltage-controlled pulse intervals

Invention

Optical pump-probe experiments are often performed in metrology and spectroscopy. The sample is first excited with an initial ultra-short optical pulse (pump), and the state of the sample is then acquired with a second ultra-short optical pulse (probe). This requires a delay time between the pump and probe pulses, which is frequently achieved with mechanical delay circuits or changes in path length. The new technology from Ruhr University Bochum now enables electrical control of the requisite sequences of pump and probe pulses or of the delay time between them. This is done by acquiring a timing signal from the first laser and transmitting it through an adjustable phase control device. This delayed timing signal controls a second laser. This concept offers various advantages: On the one hand, no mechanical moving components are used, and on the other, the pulse repetition frequency for both lasers remains the same. In addition, no direct intervention in the laser resonator is required. The use of diode lasers yields many additional advantages over complex laser systems. A high potential degree of integration is achieved, enabling an "on-chip" solution for such a system. Moreover, no external modulation frequency and no expensive signal generator are necessary.



Schematic of pulse sequence generation



Pump-probe principle for the example of a terahertz pulse

Commercial Opportunities

Pump-probe experiments are used to measure ultrafast phenomena with short laser pulses. The pump pulse can induce various physical phenomena in the sample – such as electronic excitation of a sample that can be used to investigate chemical reactions in femtochemistry. A further area of application is spectroscopy in the terahertz time frame. In this case, a pump pulse generates a terahertz signal that is recorded by the probe pulse. This method can be used for the spectral measurement of samples in the terahertz range and for coating thickness measurements of paints or plastics.

Current Status

An experimental proof of concept has been performed with appropriate laboratory measurements. An application has been submitted to the German Patent and Trade Mark Office. Further applications in other countries are possible within the priority year or in a subsequent PCT application. We offer interested companies the possibility of licensing and further development of this technology in collaboration with the inventors from Ruhr University Bochum.

Relevant Publications

Johnson, Carey K., and Jun Qian. "Picosecond laser timing by rf phase shifting." Review of scientific instruments 61.3 (1990): 1158-1160. https://doi.org/10.1063/1.1141443

Diode laser-based systems

N. Surkamp, B. Döpke, C. Brenner, K. Orend, C. Baer, T. Musch, T. Prziwarka, A. Klehr, A. Knigge, and M. R. Hofmann "Mode-locked diode lasers for THz asynchronous optical sampling", Proc. SPIE 10917, Terahertz, RF, Millimeter, and Submillimeter-Wave Technology and Applications XII, 109171C (1 March 2019); https://doi.org/10.1117/12.2508396

An invention of Ruhr University Bochum.

Competitive Advantages

- Electrically adjustable time interval
- Fewer mechanical components
- Moving parts avoided
- No direct intervention in laser resonator
- Technology can be integrated on chip

Technology Readiness Level

123456789

Experimental proof of concept

Industries

- Laser-based metrology
- Spectroscopy
- THz technology

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