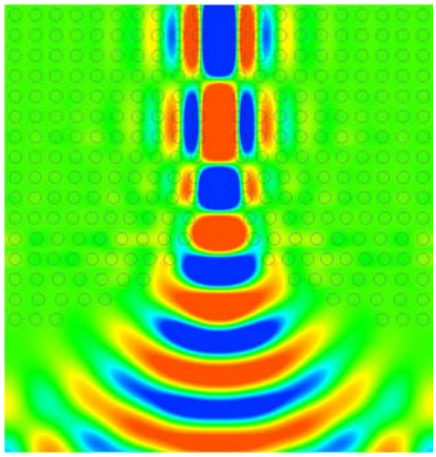
CUDOS at the University of Sydney

Research Focus

Over the past five years researchers have developed new ways to guide and control light. Fibres have been developed with micro-structured cores that allow light to be guided in air, rather than in glass. Structured materials called photonic crystals whose refractive index changes over length scales comparable to the wavelength of light have also been found to have unique optical properties – for example, prisms made of this material can be super-dispersive when compared to ordinary glass. The Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS) performs fundamental and applied research to study the propagation characteristics of light through these novel materials. Using either computer simulation or actual experiments, we can study a range of highly nonlinear optical phenomena in these new optical materials. Not only is this exciting physics, but the results can be applied to realize miniature ultra-fast all-optical circuits that may be used, for example, in next-generation communications networks.



The two key themes of our research are "microphotonics" and "ultrafast". Microphotonics is the science of microscale photonic structures and components: photonic bandgap structures, microstructured optical fibres, silicon-on-insulator based planar devices, silica photonic nanowires and nanofluidic devices. "Ultrafast" means sub-picosecond optical pulses produced with state of the art lasers. When ultrafast laser pulses travel though microphotonic structures we can observe and study a range of exciting effects including optical switching in resonant structures, nonlinear effects in highly-nonlinear glasses (e.g. chalcogenides) novel soliton effects, four-wave mixing in nonlinear optical fibres, all-optical regeneration, parametric and Raman amplifiers, and supercontinuum generation in photonic nanowires. We have student projects available in all these areas.

CUDOS facilities

Students studying theory with CUDOS use a range of codes developed specifically to solve linear and nonlinear equations of electromagnetic wave propagation in structures like photonic crystals. Some of these codes run on a 1 Teraflop parallel computer, the fastest in the country.

Experimentalists use the extensive facilities in the CUDOS lab in the School of Physics. These include a suite of high-power picosecond and femtosecond laser systems,

mode-locked fibre laser systems, and high-speed optical detection systems to study ultrafast pulse phenomena, a range of microscopic manipulation tools to couple light in and out of microphotonic devices and a suite of optical characterization tools. Some of these are in the newly opened Nanophotonics Laboratory (a Class 350 Clean Room facility).

Many of our projects involve collaboration with other nodes of CUDOS, providing access to a wide range of facilities and expertise. CUDOS, the Centre for Ultrahigh-bandwidth Devices for Optical Systems, is one of eight Centres of Excellence in the country receiving funding from the Commonwealth Government. CUDOS is a collaboration between researchers at Sydney University, Macquarie University, UTS, the Australian National University, Swinburne University of Technology, and CSIRO.