



# The 14th OptoElectronics and Communications Conference

Hong Kong

13 – 17 July 2009

## Tutorial

### Ultrafast Nonlinear Optics for Signal Processing: Breaking the Terabit-persecond Barrier

*Benjamin J. Eggleton, University of Sydney, Australia*

#### Abstract

Nonlinear optics is the branch of optics that describes the behaviour of light in nonlinear media, that is, media in which the dielectric polarization  $P$  responds nonlinearly to the electric field  $E$  of the light. This nonlinearity is typically only observed at very high light intensities such as those provided by large pulsed lasers. Importantly this nonlinearity is almost instantaneous with a response time of several tens of femtoseconds, which suggests that it can be harnessed for ultrafast information processing. For this nonlinearity to be useful we need a material with a massive nonlinear response so that the nonlinear effects can be generated at low power levels. This tutorial will review recent progress in this exciting field and will discuss the prospects for different nonlinear material systems. We have demonstrated that we can harness the ultrafast nonlinearity of certain materials for information processing and we have demonstrated a monolithic integrated photonic chip with terabit per-second bandwidth. Our approach takes advantage of different ultrafast nonlinear processes, such as four-wave-mixing and stimulated Raman scattering processes and also exploits dispersion engineering and slow-light effects. I will present our recent record-breaking results demonstrating information processing at terabit per second speeds and will discuss prospects for implementation in next generation high bandwidth information systems.



#### Benjamin Eggleton

Benjamin Eggleton is currently an ARC Federation Fellow and Professor of Physics at the University of Sydney. He is Research Director of the Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS), an ARC Centre of Excellence. He studied at the University of Sydney, obtaining his BSc (Hons) in 1992 and his PhD in Physics in 1996. After graduation, he went to the United States to join, Bell Laboratories, as a Postdoctoral Fellow in the Optical Physics Department. Soon after this, he became the Research Director of the Specialty Fiber Business Division of Bell Lab's parent company, Lucent Technologies where he drove Lucent's research program in optical fiber devices. He has co-authored more than 240 journal papers, presented more than 70 invited and plenary presentations at international conferences, and has filed 35 patents. He was an Associate Editor for IEEE Photonic Technology Letters from 2003 – 2007, and is currently Editor for Optics Communications. He now serves as the President of the Australian Optical Society.