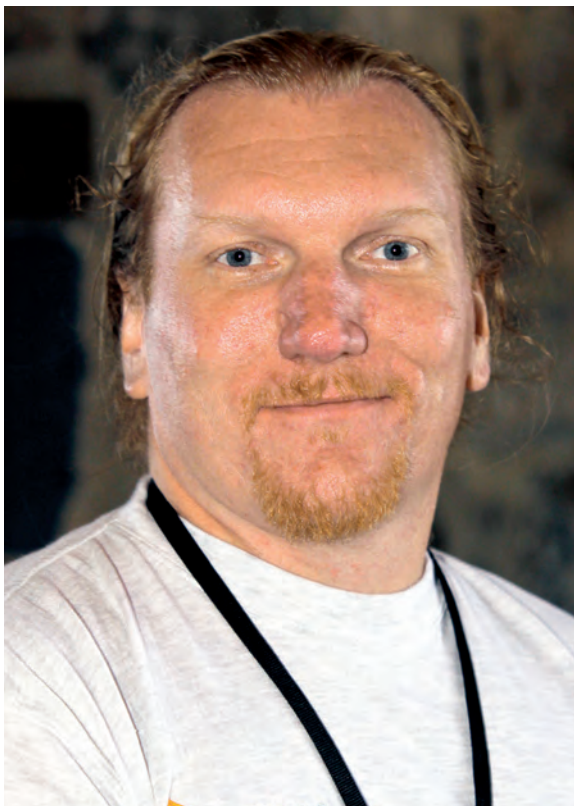
Chief Investigator: Arnan Mitchell



CI short biography

Prof.Mitchell was awarded the PhD from RMIT University in 1999 for his research into the simulation and design of high speed optical modulators on the $LiNbO_3$ integrated optic platform. His work in this field lead to the development, in collaboration with Australian defence industry and the Defence Science and Technology Organisation (DSTO), of photonic signal transport and processing devices which have been flight trialled in electronic warfare environments. He has developed two patents in the field and has licensed technology for commercialisation by Micreo Pty Ltd. More recently, he has focussed on ultrafast photonic signal processing systems for electronic warfare, $LiNbO_3$ device platforms for fundamental nonlinear photonic research, and micro-platform technologies including low-cost polymer integrated optics and microfluidic lab-on-a-chip platforms. Prof Mitchell's work in Lab-on-a-chip platforms supporting fundamental biomedical research has recently been recognised with publication in the prestigious journal 'Nature Medicine' and the award of a patent on a device for diagnosing blood clotting behaviour. Prof Mitchell leads the RMIT University node of Australian Research Council (ARC) Centre of Excellence: Ultrahigh-bandwidth Devices for Optical Systems (CUDOS), is and is leader of the Microplatform Research Group within RMIT.

Awards, honours, major international visits

Mitchell visited Prof Tom Koch at Lehigh University in PA to collaboration on his ARC Discovery project exploring lateral leakage in silicon photonics. During this visit he also established a formal collaboration agreement with the silicon photonics start-up company Lightwire.

Mitchell spent time visiting laboratories in the University of California, Los Angeles with the support of DIISR International Science Linkage funding, particularly visiting Prof Bahram Jalali gaining his support for an ARC Discovery project exploring the use of ultra-fast photonic signal processing for his recent invention 'serial time encoded amplified microscopy' (STEAM) – a video camera that could potentially reach a frame rate of 40 billion frames a second. Dr Niusha Sarkshosh (an ex student with CUDOS at RMIT) has been awarded an Endeavour Award Research Fellowship to visit Prof Jalali's group between April and Sep 2011.

He also spent time in Europe re-establishing contact with Prof Christian Karnutsch (ex-CUDOS, University of Sydney, now at The University of Applied Science, Karlsruhe, Germany). Together they have initiated an exchange program for undergraduate, honours and Masters students in the field of Nanophotonics and Optofluidics.

Mitchell also visited several universities in Dublin, particularly visiting the laboratory of Dr Brian Rodriguez, who is a pioneer in domain mapping of materials (such as LiNbO3). Dr Rodriguez subsequently travelled to Australia under the support of an RMIT Fellowship and has agreed to collaborate on the development of optical ferroelectric films for second harmonic generation that will be needed by CUDOS in 2011 and beyond.

Key areas of research contribution within the Centre

Mitchell is Project Manager for the Flagship project: Tuneable Micro-Photonics. In this role he is responsible for coordinating research interaction between CUDOS nodes involved in this project (primarily Nonlinear Physics at ANU, The University of Sydney and RMIT University) and providing platform support in LiNbO3, polymer integrated optics and microfluidics for the Flagship project. He leads a research project applying CUDOS nonlinear optics technology to microwave photonics for electronic warfare applications. This project a project aims to address the needs of end users such as DSTO and major players in the Australian and international defence industry.

Achievements 2010

This was our final year of funded research within the first phase of CUDOS and this marked the conclusion of the Flagship projects. These projects reached important milestones establishing them as viable technologies with clear pathways into the new Flagship projects in the next phase of CUDOS.

Flagship Project: Tunable Microphotonics

The goal of the tunable microphotonics platform has been to achieve the CUDOS vision of photonics on a chip with a particular emphasis on tunability. This project has three major components: Fluid infiltrated photonics, LiNbO3 platforms for nonlinear optics and Nonlinear Microwave Photonics.

Fluid Infiltrated Photonics

In 2010 RMIT has continued to pursue its polymer lamination platform which is a planar equivalent of the photonic crystal fibre. A sophisticated sensor has been designed using this technique [1] and the technique has been used to implement an array of fluid infiltrated waveguides that can achieve temperature tuned discrete diffraction [2]. An important development made with this platform this year was the demonstration of a lithographically defined fluidic interface to the arrayed fluid channels. This interface uses a hybrid of traditional photolithography and a type of nano-imprint 'injection molding'. This new technique will enable complex, and parallel interfaces between micron scale opto-fluidic waveguides below and millimetre scale microfluidic channels above. In 2011 this project will culminate in the demonstration of a planar equivalent of the infiltratated photonic crystal fibre refractive index sensors developed at the university of Sydney.

$LiNbO_3$ platforms for nonlinear optics

In this portion of the project we have been exploring novel techniques to achieve strong guiding in $LiNbO_3$ with engineered dispersion and also providing more traditional $LiNbO_3$ platforms for nonlinear experiments conducted at ANU. A major aspect of this work has been the etching of $LiNbO_3$ using our newly discovered etching during the indiffusion of titanium (EDIT) technique[3]. The CUDOS student Vijay Sivan has successfully completed his PhD. It has been shown that the EDIT process can produce waveguiding [4] and the development of these waveguides and their use as a platform for periodic poling for second harmonic generation is currently being pursued by the CUDOS PhD student Tristan Crasto. More traditional titanium indiffused waveguides with photorefractive nonlinearity have been provided to ANU and enabled the observation of truncated Bloch waves [5]. $LiNbO_3$ will remain an important platform for CUDOS moving forward with applications specifically in quantum information processing.

Nonlinear Microwave Photonics

A primary aim of the tunable microphotonics flagship project is the realisation of a microwave photonics platform that can be used for electronic warfare applications. Our investigations have continued into the use of nonlinear optics to achieve all-optical frequency measurement. We have extended this system showing that parallel IFM measurements can be made within a single highly nonlinear optical fibre [6]. This advancement will enable us to implement arrays of IFM systems so that unambiguous measurements of both amplitude and phase can be made without a significant increase in component count. We have also demonstrated that the entire frequency measurement system can be remoted from the transmitter [7]. These two advancements make it possible to consider an integrated chip version of this system which should be of interest to our collaborators in the defence industry. Our leadership in the field of Microwave Photonic signal processing has been recognised with two invited talks [8,9]. This work on ultrafast analogue photonic signal processing will be pursued further in the next phase of CUDOS specifically in the field of Tb/s analogue to digital conversion. The integration of our IFM system into a photonic chip will be pursued under the hybrid integration flagship with the support of an industry partner.

Researchers and students

Dr Lam Bui	Dr Vijay Sivan
Mr Eike Zeller	Mr Kushan Dayaratne
Mr Tanveer Mahmud	Mr Tim Lunn

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