



The Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS)

Vision

CUDOS will be a world-leading Centre in microphotonics, with internationally pre-eminent research underpinning a strategic focus on all-optical signal processing devices.

Mission

CUDOS will conduct fundamental strategic research aimed at demonstrating and developing technology for optical processing devices that will enhance Australia's communications infrastructure and our status as a technologically-advanced economy.



CUDOS gratefully acknowledges the support of the Australian Research Council. We also acknowledge the financial and in-kind support provided by the Collaborators – The University of Sydney, the Australian National University, Macquarie University, the University of Technology Sydney, Swinburne University of Technology, and RMIT University. Financial support provided by the New South Wales State Government through the Office of Science and Medical Research is greatly appreciated.



Australian Government
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Department of State and
Regional Development

Ben Eggleton



This Annual Report brings a formal close to the Centre that commenced operation in 2003. Our first Annual Report listed 23 publications in refereed journals from 12 Chief Investigators, 5 Partner Investigators, 30 associated research staff and 26 students. The average impact factor of the journals in which we published our results was 3.3. Comparison of those figures with the numbers in last year's report shows more than a doubling of output across all sectors of our performance: our annual publication output is greater than 70 with an average citation figure 3.4 (close to A* average), the number of our Partner Investigators has more than doubled to 11 while numbers of research staff have increased from 30 to 47 and student numbers from 26 to 62.

It's noteworthy that this extraordinary growth in our research output and student numbers has occurred with very little increase in funding to the Centre over this time, and that with the exception of one new Collaborator (RMIT through Prof Arnan Mitchell) our complement of Chief Investigators is relatively unchanged. We attribute the dramatic increase to three factors: first, the tremendous multiplicative value of our strong collaborations; second, the depth and breadth of opportunity in the exciting field of research in which we operate; and third, the quality of the advanced research infrastructure that we have steadily developed over the past eight years.

These factors are worth exploring in more detail. Collaboration is the key to our program, and our major advances have come from our collaborative programs. Examples include the successful collaboration between Sydney, ANU and the Danish Technical University on chalcogenide devices; Sydney, ANU and St

Andrews on nonlinear photonics and RMIT and ANU on tunable microphotonics. In each case one university group relies and capitalises on the expertise of the other in a complementary area. The output of this effort could not be produced by either team alone. Not only does this lead to joint publications (around 25% of our publications have authorship across multiple nodes) but it establishes a capability in each university on which to grow further research activity.

The second factor is the field of research. When CUDOS commenced in 2003, our visionary goal was to employ nonlinear photonics to demonstrate all-optical switching. Since that time this field has grown exponentially, driven by strong interest in the use of silicon as a material. Our approach based on chalcogenide has been producing results at the very forefront of the field because of the very high nonlinearity of this material and its ultrafast response. With the growth of the field, more groups have become interested in our work and in collaborating with us – hence the doubling in our number of Partner Investigators and the role that CUDOS is now playing in major international programs like SOFI, headquartered in Europe. In turn, these collaborations have opened new opportunities for us: for example, we now have our own vigorous program in silicon photonics. This has led to a series of Nature Photonics publications, all of which serve to consolidate our position as an international leader and drive further linkages. It has also led to industry involvement, and successful commercialisation of research outcomes.

The third factor is our research infrastructure. Using Centre funds, large equipment grants, and university support our nodes have built facilities of major national importance like the Tb/s bit error rate test bed at Sydney, the chalcogenide fabrication, deposition and lithography facility at ANU, and the nanoscale fabrication facilities at Swinburne. These unique facilities give our researchers a crucial international competitive edge. Additionally, our researchers have supported and benefited from the nanofabrication capabilities funded by NCRIS at the ANU. Our facilities will be further strengthened by recent awards under LIEF of funding to strengthen our Tb/s test bed in Sydney and a new sub-diffraction limit imaging and writing system at Swinburne.

While the Centre brings benefits to all staff associated with it, I take particular pride in seeing the enjoyment by our students of the 'CUDOS experience'. This is multi-faceted, from the strong research mentoring program through to the CUDOS student competitions, the student-focused sessions at the Workshop and the CUDOS-sponsored OSA student chapters that provide enrichment and leadership opportunities for our future research leaders.

CUDOS 2011 and beyond: The outstanding success of our program over the past eight years gave our CUDOS team the motivation and commitment to develop and present to the ARC a new proposal for an exciting seven year program of research. I'm delighted that the ARC announced mid-year that it will support this program at very close to the level we had proposed.

The effort that went into preparing the three stages of the proposal (expression of interest, final submission and interview) was a true team effort involving many members of the Centre from the Advisory Board to senior staff in the Centre through to Chief Investigators and researchers. My thanks to all, and especially the interview team that travelled to Canberra with me: Dr Greg Clark, the Advisory Board chair from 2011, Prof Jill Trehwella,



Chairman's Introduction

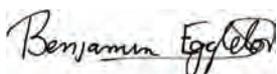
DVC(Research) at Sydney, Prof Yuri Kivshar, Prof Martijn de Sterke, and Prof Arthur Lowery of Monash, who will join CUDOS in 2011 as a Chief Investigator.

There is a huge amount of enthusiasm for this program, with its bold new activities in quantum integrated photonics and metamaterials (including nano plasmonics) and mid infrared photonics, along with an exciting break-through program in hybrid integration techniques to complement our ambitious program in terabit per second photonics. We will formally unveil the new program at our 2011 Workshop, at which we will summarise the outcomes of the 2003 – 2010 program before moving on to a series of presentations from Chief and Partner Investigators that illustrate the exciting challenges that lie ahead of us.

Individual honours: I take great pleasure in celebrating the honours that are awarded during the year to my colleagues in the Centre, both staff and students. In 2010 one of our foundation Chief Investigators, Professor Min Gu of Swinburne, was awarded a prestigious Laureate Fellowship by the ARC. With this award Min will pursue research in advanced imaging techniques for the fabrication of three dimensional structures for optical data storage. The expertise that Min both applies and gains in the course of this project will directly benefit the nano-plasmonics and metamaterials programs in CUDOS, where one of the aims is to fabricate nanometre scale three-dimensional structures that exhibit unique optical properties including negative refraction. During the year I was delighted to receive the Scopus Young Researcher of the Year Award for Physical Sciences. Prof. Yuri Kivshar was awarded the title "Distinguished Professor" corresponding to the level E3 Professor at ANU. One of our students Dr Ivan Garanovich received the J G Crawford Prize for 2009 for his PhD thesis; this is one of two top awards of the Australian National University for the best PhD thesis in all fields.

A number of our colleagues have left the Centre to the next stage of their career, including Dr Christelle Monat (now a lecturer at Lyon) and Dr Christian Karnutsch (who has a professorship at the Karlsruhe Technical Institute). The Centre has benefited from their research expertise and I'm delighted that their experience with the Centre has given them the CV to obtain such prestigious positions. Good luck to them both!

I also want to thank and acknowledge our wonderful Advisory Board, chaired by Dr Bob Watts. Bob in particular has been a mentor to me and I thank him for his inspirational guidance. Bob, Dr Ian Ritchie, and Mr Warwick Watkins are retiring from the Board this year. Dr Steve Frisken also retires from the Board but remains with us as a Partner Investigator. Mr Laurie Bode, Professor Jim Williams, Professor Jim Piper and Professor Jill Trehwella will be joined by Dr Greg Clark as Chairman of the new Board and other new members. I thank all our Board members for their commitment, sound advice, and enthusiastic support of the Centre over the years.



Research Director, CUDOS

ARC Federation Fellow

The Board was delighted to receive the news that CUDOS has received support from the ARC to grow and extend its exciting research program in photonic integrated circuits. This program is the only one of its kind in Australia. In terms of its scope and effort, CUDOS is a major player in this internationally exciting area. While the program is principally about strategic research to position Australia at the forefront of this field over the next ten years, the Board is also pleased that Ben and his team are mindful of the commercial potential of their work, with at least one commercial success to date arising from a Linkage project in an area closely related to the Centre.



The Board met once during the year to provide strategic advice to Ben and his team on the structure and presentation of the proposal to the ARC. I also attended a number of rehearsals and meetings during the preparation phase.

I am standing down from the Board, as are a number of my colleagues and I take this opportunity to thank them for their services. Mr Warwick Watkins has been on the Board since 2003 and his advice and wisdom have been greatly appreciated. Dr Ian Ritchie and Dr Steve Frisken have provided the commercial perspective so important in a Centre of Excellence, and Dr David Skellern brought his unique perspective as the leader of Australia's largest ICT research body, NICTA. It was a pleasure to work with this group which also included Prof Jim Piper, Mr Laurie Bode and Prof Jill Trehwella, all of whom will be continuing to serve on the Board of the new Centre. I wish my successor, Dr Greg Clark, all the best in his role. I am sure he will relish it.

Last, I wish Ben and his team all the success in the future. It has been a pleasure to work with such an enthusiastic team of world beaters, led by a Director with vision, commitment and drive second to none. All the best to CUDOS for the next seven years!

Dr Bob Watts FAA, FTSE, FRACI

Chair, Advisory Board