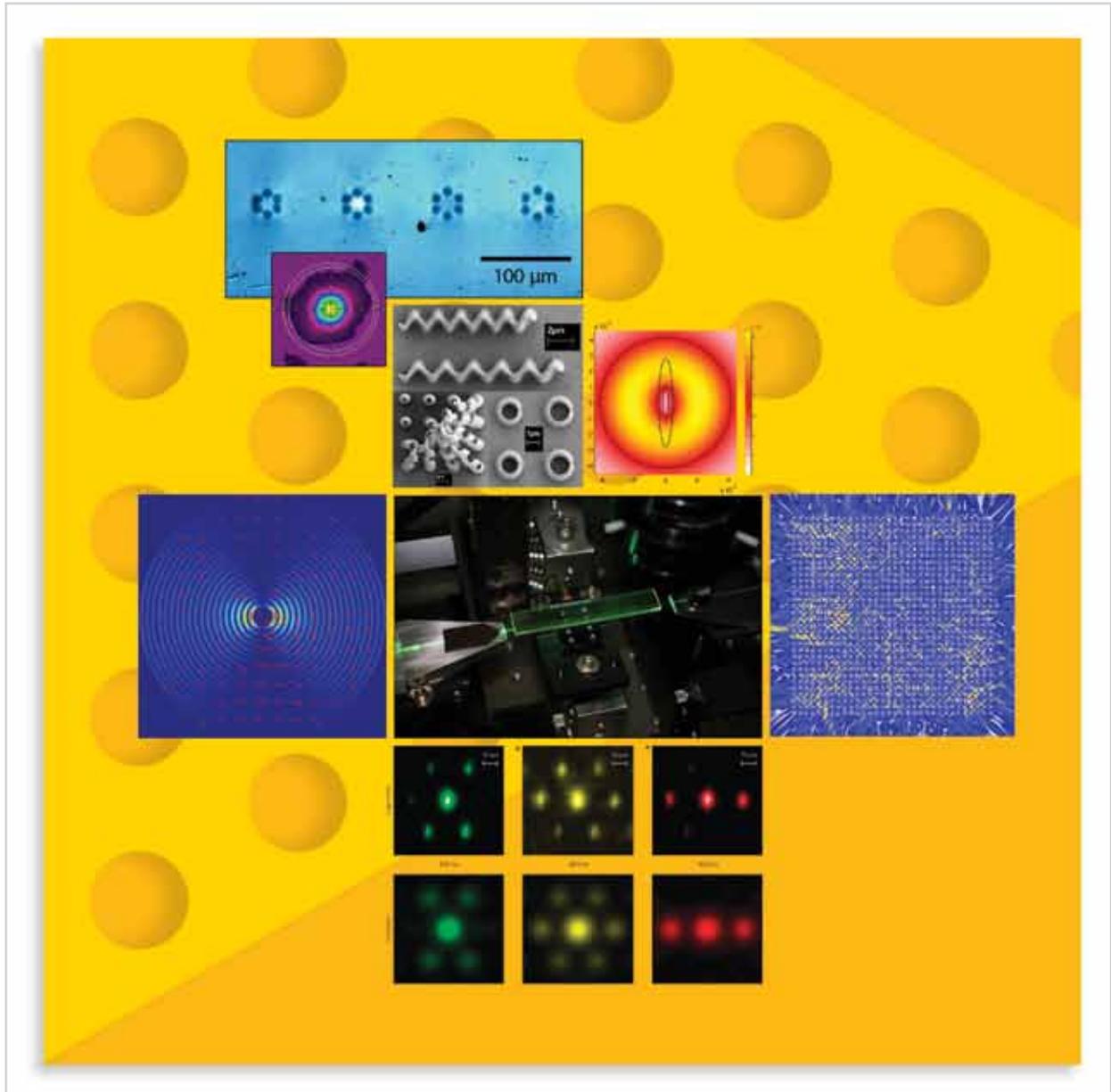


ANNUAL 2009 REPORT



CUDOS

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



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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. Finally, we are grateful for financial support provided by the New South Wales Government through the Department of State and Regional Development.



Australian Government
Australian Research Council



Department of State and
Regional Development

Research Director's Introduction

Ben Eggleton



The expression 'firing on all cylinders' accurately describes CUDOS during 2009. The quality of our research outcomes flows from, and is indicative of, the quality of the cohesion and collaboration across the Centre and the strength of the linkages with our Partner Investigators. Nowhere better is this demonstrated than in three articles published in *Nature Photonics* and *Nature Physics* during the year in which Centre researchers and their collaborators described new advances in fundamental science. These build on publications in other prestige journals including *Advanced Materials* and *Physical Review Letters*.

In one publication, a completely unexpected observation of third harmonic generation of green light in silicon was reported and explained in terms of enhanced interaction due to slow light propagation. In a second, dynamic localisation of light in photonic lattices was observed experimentally and studied theoretically, while in the third an all optical approach was demonstrated to high bandwidth RF spectral analysis of a data stream at Gb/s rates and beyond.

These publications, all at the forefront of the field, ranged across studies of fundamental behaviour of light in guided media, novel experimental results obtained in sophisticated devices fabricated collaboratively with Partner Investigators in Europe, and completely novel approaches for engineering solutions to next-generation optical communications systems. This demonstrates the strength of a Centre like CUDOS, where research of the highest quality in photonics is conducted over the full spectrum - from pure to applied, and from theory to experiment to application - with close coupling and collaboration providing the critical mass to consistently achieve research outputs of the highest quality.

Still on research, we were delighted with the continued growth of the Wave Shaper product commercialised in 2008 by Finisar from collaborative research conducted on the CUDOS 320 Gb/s optical test bed. Finisar continues to collaborate with us and contribute to our research program in ultrafast optical signal processing.

While some of our research activities commenced in 2003 are coming to fruition, others are just starting. Exciting new areas like metamaterials, plasmonics and the whole field of sub-wavelength optics are growing rapidly, fuelled by seminal advances and recent breakthroughs in nanofabrication of composite materials built from sub-wavelength elements. The Centre is actively pursuing research in these new fields, to ensure that Australia is well-positioned over the coming decade to lead this new wave of research and development toward eventual application.

Workshop

The CUDOS Workshop is always a highlight for the year. This year our meeting was held at Lake Crackenback resort, near Thredbo in the Snowy Mountains. Despite unseasonably cold weather (including snow the day of our session at the Blue Cow resort!) there seemed to be general agreement that this was 'the best ever' Workshop. As always, we had a student poster session which was judged by three of our international visitors, with prizes for the best presenters. The students turned the tables later in the week with their own presentations to staff. Awards relevant to each category were presented, including a pair of scissors to the presenter with too much content in the poster, a (toy) mobile phone to the best spruiker and a toy bulldozer to the hardest working presenter.

We were honoured to have John Sipe from the University of Toronto join us to present his thoughts on 'Nonlinear quantum optics on a chip', and were equally delighted to welcome an excellent cohort of our Partner Investigators and other visitors. These included Tony Wilson (Oxford); Hugo Thienpont, Nathalie Vermeulen, Christof Debaes (VUB) along with Jurgen van Erps who spent three months at the University of Sydney following the Workshop; John Harvey (Auckland); Tobias Kampfrath (AMOLF) representing Kobus Kuipers; Nikola Alic (UCSD) representing Stojan Radic; and Leif Oxenløwe (DTU), our collaborator in the 640 Gb/s OTDM experiment.

Chairman's Introduction

A/Professor Judith Dawes demonstrated the Photonic Simulator, a knowledge and skill-based 'game' designed to assist high school students in learning about photonic circuit operation and functions. This work was subsequently presented at the SPIE's Education and Training in Optics & Photonics meeting and was highly commended as an entrant in Engineering Australia's Education and Training category of the Engineering Excellence Awards (Sydney Division).

International Conference Organisation

The Centre's strong research presence in photonic crystals was rewarded with an invitation to hold the 8th International Photonic & Electromagnetic Crystal Structures (PECS) Meeting in Sydney in April 2009. This meeting, which brings together researchers in photonic crystals and related areas like metamaterials, is quite simply the premier meeting for this field. To have it in Sydney provided a wonderful opportunity for all our students and researchers to hear talks from and rub shoulders with research giants like Martin Green, Eli Yablonovitch and Sir John Pendry. I convened the meeting along with Yuri Kivshar, and other members of CUDOS played a major role in both the organisation and program selection. While this was a superb team effort by all those involved, I do want to acknowledge the efforts of Mike Steel and Christelle Monat who played particularly active roles on the Program Committee.

The efforts of all my CUDOS colleagues, both staff and students, were recognised during the year through a number of awards and honours. Included in these is Dr Christian Rosberg, a student of Yuri Kivshar, who was awarded the prestigious Bragg Gold Medal of the AIP for the best PhD thesis in 2009. I was elected a Fellow of the IEEE and a Fellow of the Academy of Technological Science and Engineering during the year and Dr Boris Kuhlmeier was awarded an ARC Future Fellowship.

Finally, I acknowledge the leadership shown by CUDOS students in establishing Optical Society of America Student Chapters in Australia. There are presently five such chapters with four of these formed and led by CUDOS students (at Sydney, Macquarie, Swinburne and ANU). These chapters have played an important role in raising the profile of Optics and Photonics within the student communities, initiated high-impact outreach activities in high schools and provided networking opportunities both nationally and internationally for student members. CUDOS is proud of our students' initiative and delighted to provide sponsorship for these chapters and their activities.



Research Director, CUDOS

ARC Federation Fellow

The CUDOS Advisory Board met once in 2009 and received detailed reports from Ben about Centre activities and about photonics activities generally in the Australian landscape. The Board was delighted to hear about the excellent research results the Centre had achieved during the year as well as about activities driven by CUDOS including the formation of the Institute of Photonics and Optical Science at the University of Sydney with an accompanying Masters coursework degree.

I attended the launch of the Institute, which incorporates the Sydney University-based activities of CUDOS as well as other photonics-related groups at the University, and the accompanying Symposium. CUDOS Partner Investigator Alan Wilner of University of Southern California flew in specially to give the plenary presentation at the Symposium on the future of optical communications research. The invited speakers at the Symposium demonstrated, through their presentations, the broad applicability of photonics across science, engineering and biomedical research.

I am particularly pleased to hear about the establishment of a new Masters degree. For some time the Board has emphasised the need to train professionals who have the specialised skills and knowledge to work in the industries created from the research outcomes of a Centre of Excellence. The Masters program established at Sydney has a strong vocational training component and will admirably address this need.

Dr Bob Watts FAA, FTSE, FRACI

Chair, Advisory Board

