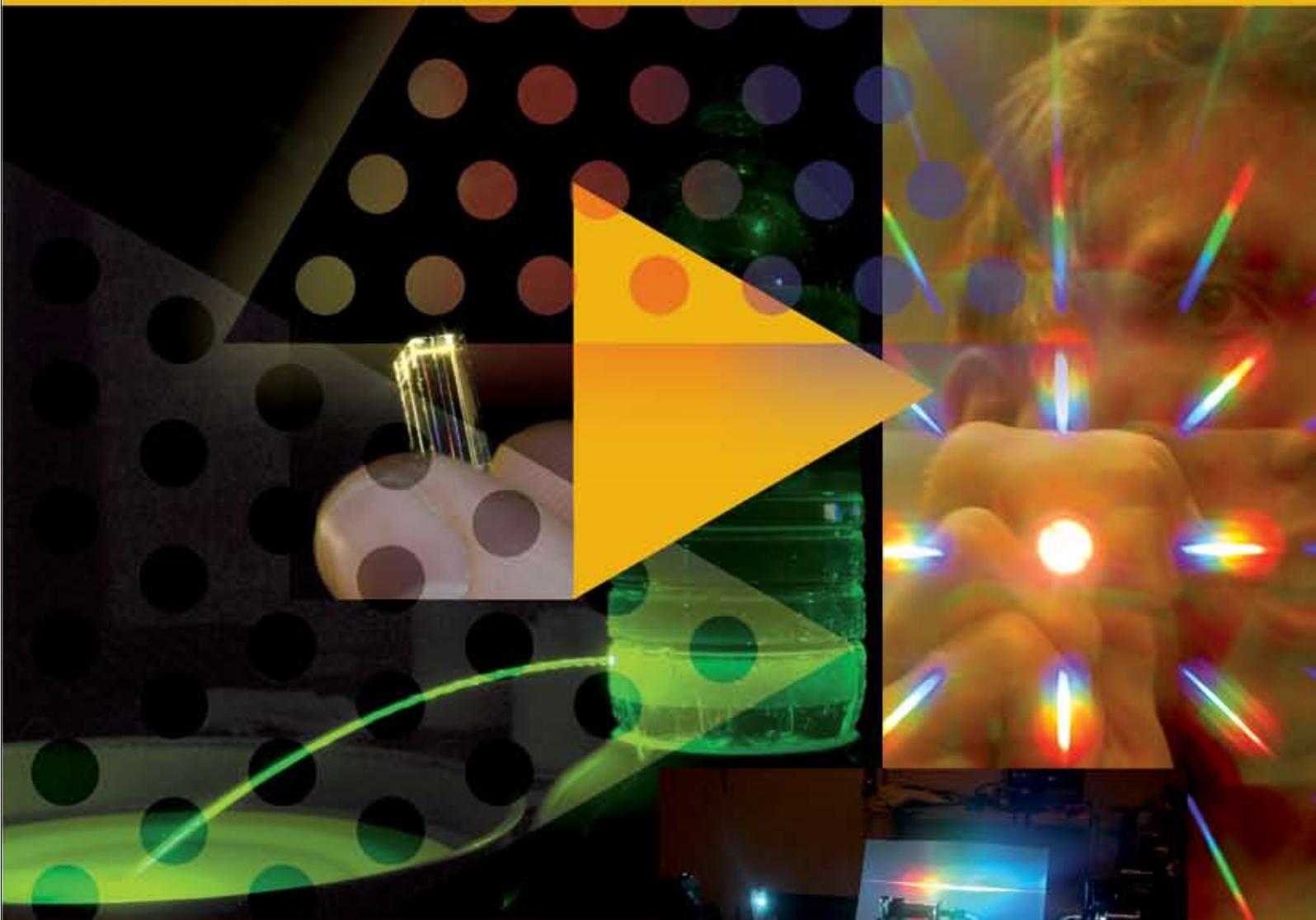


# CUDOS

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



A N N U A L R E P O R T

2006

During 2006 CUDOS built on our strong peer to peer links to initiate a range of formal collaborations with research institutions and consortia in Australia and internationally.

## New Chief Investigator

CUDOS is delighted to welcome Dr Arnan Mitchell of the Microelectronics Materials and Technology Centre at RMIT University as a Chief Investigator. While RMIT will formally join the collaboration in 2008, Arnan is already playing a major role in the Centre's research and is a de facto Chief Investigator. Dr Mitchell brings a new and exciting capability in electro optics to the Centre. He is one of Australia's leading researchers in the field of high-speed integrated electro-optics, with particular expertise in the simulation, design, fabrication and packaging of high-speed LiNbO<sub>3</sub> information processing devices. He has significant expertise and experience in broadband photonic signal processing for defence applications, a role which will be central in CUDOS' developing collaboration with DSTO. He has collaborated extensively with ANU in the field on nonlinear optics in periodic LiNbO<sub>3</sub> waveguides and Sydney in tunable devices based on microfluidics.

**Arnan Mitchell**



## New Partner Investigators

In recognition of the changing nature of its research emphasis, CUDOS has invited a number of new Partner Investigators to join the Centre's research program as we move into our extension phase (2008 – 2010). Each Partner Investigator brings unique skills and capabilities to one or other of our Flagship projects that complement the skills and capabilities of the existing collaborators:

**Joss Bland-Hawthorn** is Head of Instrument Science at the Anglo-Australian Observatory. He is an expert on novel astronomical instrumentation and will collaborate with CUDOS on the development of new compact photonic spectrometers for astronomy as part of a new Flagship project on mid infrared applications.

**John Harvey** is Professor of Physics at Auckland University, and CEO of Southern Photonics, a company formed to commercialise novel photonic instrumentation. He will collaborate with CUDOS on novel parametric devices and pulse characterisation techniques as part of the Nonlinear Optical Signal Processors Flagship.

**John Haub** is the Head, Electro-Optic Technologies in the Electronic Warfare and Radar Division of DSTO. Dr Haub and his team will collaborate with CUDOS as part of the Compact Waveguide Amplifiers and Tunable Microphotonics Flagships.

**Satoshi Kawata** is Professor in the Department of Applied Physics at Osaka University. He has been a PI in CUDOS since its inception in 2003, and collaborates with CUDOS as part of the Three Dimensional Photonic Crystals Flagship.

**Thomas Krauss** is Professor of Physics at St Andrews University, Scotland. He leads the major European project 'SPLASH' on slow light and will collaborate with CUDOS on our Slow Light and Optical Switch Flagship projects.

**Kobus Kuipers** is Professor in the Center for Nanophotonics at the FOM Institute for Atomic and Molecular Physics, Amsterdam, the Netherlands. He is an expert on near field imaging and will bring this expertise to the Slow Light Flagship.

**Thas Nirmalathas** is an Associate Professor at Melbourne University and the Program Leader for Networking Technologies in National ICT Australia (NICTA). He and his group will collaborate closely with CUDOS as part of the Nonlinear Optical Signal Processors Flagship.

**Stojan Radic** is an Associate Professor in Electrical & Computer Engineering at the University of California at San Diego. His expertise in parametric devices and all-optical processing schemes will complement that of CUDOS and other PIs in the Nonlinear Optical Signal Processors and mid infrared Flagships.

**Adel Rahmani** is a researcher at LEOM/Centre National de la Recherche Scientifique (Lyon, France) with expertise in scattering, radiation dynamics and optical microscopy. He will contribute to the Three Dimensional Photonic Crystals and Slow Light Flagships.

**Kathleen Richardson** is Professor and Head of the School of Materials Science and Engineering at Clemson University. A PI with CUDOS since 2003, she is an acknowledged expert in the fabrication and characterisation of chalcogenide glass, a key technology platform for a number of CUDOS Flagships.

**Mike Steel** is a Senior Research Scientist with RSoft Design Group of the US. He has been an Honorary Associate at the University of Sydney since 2003 and a strong CUDOS collaborator. He will lead the effort in applying a range of sophisticated modeling tools to detailed simulation of existing CUDOS experiments and new directions across a number of Flagships.

**Hugo Thienpont** is Professor in the Department of Applied Physics at Vrije Universiteit Brussel, Belgium. His research expertise and wide range of experimental facilities particularly in mid infrared photonics and photonic crystal fibres will enable him to contribute to a number of Flagships including Tunable Microphotonics, Nonlinear Optical Signal Processors and Mid Infrared Photonics.

**Alan Willner** is Professor of Electrical Engineering at the University of Southern California, Los Angeles. As an acknowledged leader in optical networking research, he will play a key collaborative role in the Nonlinear Optical Signal Processors Flagship.

**Tony Wilson** is Professor of Physics at Oxford University and a world expert in optical microscopy. His expertise will play a key role in development of aberration – correcting optics required for the Three Dimensional Photonic Bandgap Materials Flagship.

## National links to NICTA, DSTO and AAO

National ICT Australia (NICTA) and the Defence Science and Technology Organisation (DSTO) conduct research directed towards end users in the ICT and defence communities. Through establishing collaborations with these organisations, CUDOS research is more closely aligned with the requirements of end users in these areas. The Anglo Australian Observatory is both an end user itself and a collaborator with other observatories and astronomy service providers.

Our links with these three organisations have been established in a formal sense by involving senior researchers in the Centre as Partner Investigators (NICTA – A/Prof Nirmalathas; DSTO – Dr Haub; AAO – Dr Bland-Hawthorn). During November we held joint workshops with each group to identify areas of common interest and establish collaborative opportunities. The NICTA – CUDOS Workshop ran over two days and was attended by ten members of each group, with CUDOS members coming from Sydney University, Macquarie, ANU and RMIT (see figures).



▲ Attendees of the CUDOS-NICTA Workshop held at Sydney University on 27th and 28th of November.

Both workshops identified exciting collaborative projects. Detailed project planning will be carried out at the Centre's next Workshop, which will be held in February at Bateman's Bay and attended by all new Partner Investigators as well as other representatives from NICTA, DSTO and the AAO.

## European Links

**Network of Excellence on Micro-Optics (NEMO):** CUDOS has been approved for consideration as an Associate Member of this Network of Excellence, coordinated by Professor Thienpont (Vrije Universiteit Brussel). This Network, with thirty partners throughout Europe, provides a strong platform for development of collaborative project opportunities. Professor Thienpont will be joining CUDOS as a Partner Investigator as part of the extension phase of the Centre (2008 – 2010).

**COST Action 299 (Fibres Dedicated to Society – FIDES):** The COST program (European Co-operation in the field of Scientific and Technical Research) is an intergovernmental framework for coordination and co-operation of nationally funded research. COST Actions often lead to project proposals for funding under the EU Framework and other programs. Ben Eggleton is playing a leading role in COST Action 299 (<http://www.cost299.org/>),



▲ Chris Walsh (COO), Hugo Thienpont (future PI from NEMO) and Ben Eggleton (Research Director) at the 6th CUDOS Workshop.

attending meetings in Brussels (May) and Nice (September), where he made the technical presentation on behalf of one of the four working groups. CUDOS is the only non-European member of this COST Action.

**PHOREMOST Network of Excellence:** CUDOS is an Associate Member of this Network, with Ross McPhedran playing an active role.

**CUDOS at ECOC 2006:** The European Conference on Optical Communications (ECOC) is one of the two main international conferences in optical networking technologies, the other being the US-based OFC Conference. ECOC is a technical meeting accompanied by an exhibition attended by over 4,000 visitors and conference delegates. CUDOS reserved space at the 2006 exhibition to provide information to Europeans on our research capabilities, facilities and collaboration opportunities. Over fifty delegates visited the stand during the three days of the exhibition, with useful new links being established with at least five organizations.



▲ Ben Eggleton and Chris Walsh at the ECOC 2006 booth

**Other links:** Judith Dawes has established a collaboration with Martin Pemble of Tyndall Institute in Ireland on the growth, characterization and exploitation of rare-earth-ion-doped photonic crystal materials. This will run over three years and is supported by an International Science Linkages Grant.



## Conference Activity

**ETOPIM 7:** Centre staff played leading role in organizing the 7th International Conference on the Electronic, Transport and Optical Properties of Inhomogeneous Media, held at Darling Harbour in Sydney. Ross McPhedran was Co-convenor of the meeting; Boris Kuhlmeier was the Conference Secretary and Lindsay Botten and Yuri Kivshar were on the Organising Committee. Approximately 140 people attended the meeting including a large number of international speakers.

**ACOFT/AOS 2006:** The Australian Conference on Optical Fibre Technology is the major yearly meeting for photonics researchers in Australia. This year's meeting was held jointly with the Australian Optical Society meeting at RMIT with Dr Arnan Mitchell (presently CUDOS Associate Member and Chief Investigator from 2007) chairing the Program Committee. CUDOS researchers presented just under one quarter of all the papers at this combined meeting.

## Commercialisation

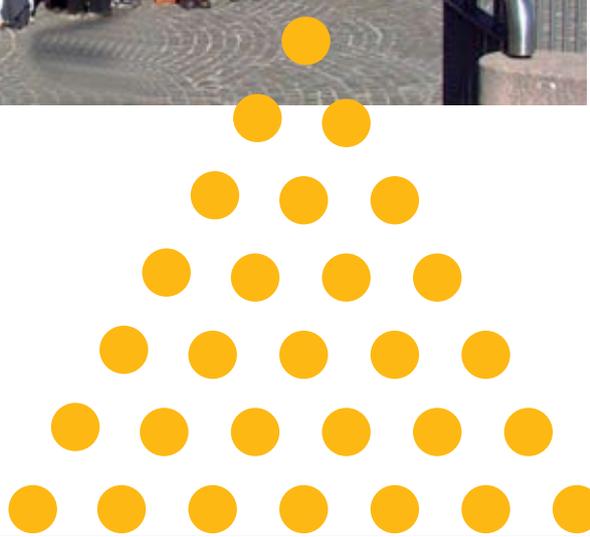
The Centre is well-positioned to commercialise outcomes of its research. As the discussion earlier in this Report indicates, we are building on and adding value to our strong research base as part of the Centre's evolution. Our Flagship projects are the most visible component of this strategy. Most importantly within

a commercialisation context, Flagship projects strengthen our end user links, which in turn facilitate commercialisation opportunities. With an IP strategy in place and end user links developing, we expect to see significant commercialisation opportunities arise within the next three years.

Notwithstanding this, the Centre was approached during 2006 by a venture capital company. The Company proposed to survey CUDOS technology with a view to identifying an area for possible pre-seed investment. The survey was carried out in the last quarter of 2006 using an external consultant. The report identifying an investment opportunity has been provided to the Company and negotiations regarding pre-seed funding are underway.

Researchers at the University of Sydney are collaborating, via a Linkage grant, with Optium (Australia) Inc. The outcomes of the project will lead to crucial innovations in reconfigurable ultrahigh bit rate optical networks whose deployment in Australia will lead to widespread availability of broadband data communications services. While the activities of the project are outside the scope of CUDOS, researchers on the project collaborate closely with other CUDOS researchers and use CUDOS experimental and other facilities.

▲ Group photo from ETOPIM7, Dockside, Cockle Bay Wharf, Darling Harbour, July 9-13, which had around 140 registered participants. CUDOS was a sponsor of this conference and was represented in both the organization and its program.







## Outreach Coordinator: Kali Madden

actively involved in Outreach presentations and aim to grow this number in the coming years.

### **Target Audience**

School students from Years 8 right through to Year 11 had the opportunity to learn more about science, photonics, optics and CUDOS this year in a number of school talks, work experience and a science careers expo.

High school science teachers were strongly supported with three professional development events throughout the year.

Industry events included specially developed posters, seminars and talks in Newcastle, Sydney and Melbourne.

### **Background**

Communication of scientific research in non-technical terms is critical in achieving broader public awareness and engagement in science, and attracting research talent into the field. Global emphasis on monitoring the impact of scientific research highlights the importance of knowledge diffusion through communications and outreach.

Effective science communication not only enhances collaboration between disciplines (interdisciplinary research) but facilitates dialogues between science, humanities and the arts. Effective outreach entails communicating broader scientific concepts to the public (whether schools, industry, other disciplines, or the general public) in engaging and accessible ways. This requires specialist skills, resources and planning not always available in the day-to-day operations of a research centre without some coordination, training and development.

To address these points we introduced a national outreach program for CUDOS whose aim was to enhance communications efficiency and effectiveness, to foster communications best practice, and to reduce fragmentation of outreach efforts across the centre. The program is coordinated by Kali Madden at Macquarie with node representatives Emily Higginson (Sydney), Judith Dawes (Macquarie), Wendy Quinn (ANU), Kokou Dossou (UTS) and Katie Cage (Swinburne). Our Outreach activities have a strategic plan developed in consultation with the Research Director and COO, with operational targets for 2006 that are discussed in this report.

### **Focus**

The primary focus of the national CUDOS outreach program in 2006 was to generate opportunities for schools in particular but also industry and the general public to engage with our science in fun, practical and supportive ways. At the same time we learn more about what these groups want to know and how our members can contribute their time and skills to support community needs.

To support this we worked on recruiting and fostering communicators within the Centre, particularly within the CUDOS student body. We found a strong level of enthusiasm and commitment from our students who engaged in a number of communications and outreach activities discussed in more detail below.

### **Accomplishments**

#### **Program Participation**

Many members of CUDOS contributed to the planning, preparation and implementation of activities: students, lecturers, researchers, administrators and senior management across multiple institutions – all hands on deck! At present we have nearly a dozen students



▲ **High School students in the ACT learning about CUDOS and light.**

#### **Communication Mediums, Format and Duration**

We tested a number of communication mediums including general information posters, lectures, multi-media presentations, articles, demonstrations and hands-on activities and exercises, all tailored for our audience. Sometimes we went out to visit others and sometimes people came to visit us on site. We also communicated our work through electronic media including participation in the World Wide Day in Science, a global online science careers initiative.

We experimented with short talks and presentations, medium length workshops and theme days and several longer term projects including a 2-day science careers expo and a 3-day teacher visit. More information on the 2006 activities may be found at <http://www.cudos.org.au/cudos/education/outreach.php>

#### **Highlights**

There were many successful and rewarding moments in Outreach this year, some of which are highlighted below.

Visiting scholar Prof Thomas Brown (Institute of Optics, University of Rochester) gave a scintillating lecture aimed particularly at high school science teachers, though also attracting interest from the public and from science communication professionals. The lecture was entitled "Kitchen sink optics and other curiosities of light" and in it Prof Brown highlighted the significance of CUDOS research contributions to the global optics community and encouraged teachers to take note of this expertise in their own back yard.

Prof Brown demonstrated key concepts throughout the talk and distributed an optics education kit for teachers to utilize in their classes. A DVD of the event was made to distribute to interested teachers as an added resource.



▲ Professor Tom Brown at Sydney University.

The annual CUDOS student competition this year focused on writing science articles for the popular press. The article by 1st prize winner Peter Domachuk was published online in COSMOS magazine [www.cosmosmagazine.com/node/516]. Several of the entries were reproduced in the Australian Optical Society magazine and 3rd prize winner Luke Stewart was profiled in an October edition of "Future Materials News".

Students in the OSA student chapter at the ANU developed a poster providing an overview of their work, and also initiated, planned, prepared and delivered a school presentation. The presentation was delivered to an Advanced Science class of about 54 boys and girls and was very well received. The talk preparation included dialogue with others outside the discipline, email liaison with teachers to determine an appropriate level to pitch it at, and input in the talk development by a whole team demonstrating effective communication, collaboration and teamwork.

We participated in a successful event showcasing local science in a format developed especially for industry at Macquarie University. Martin Ams won the People's Choice Award and \$500 for his scientific poster.

The three Sydney-based CUDOS universities participated in Science EXPOsed, a science careers fair open to the public at Hyde Park Barracks in Sydney. Through displays and direct interaction, our staff and students introduced the concepts and applications of photonics to Yrs 8 & 9 students and their teachers.

Collaboration between the NSW CSIRO Science Education Centre and the Macquarie University node resulted in a novel pilot program for high school science teachers to undertake self-directed professional development during a 3-day visit to CUDOS. One of the participating teachers commented "I would definitely recommend this programme for a senior physics teacher. I was able to become totally absorbed in my favourite subject for 3 days with patient experts – what a treat! My brain received some welcome exercise."

Ben Eggleton traveled to Newcastle to present a general talk on photonics and optical networks to the Newcastle Branch of Engineers Australia. The talk, attended by more than thirty local engineers, attracted considerable discussion.



▲ Ben Eggleton and Michael Scott in Newcastle for Ben's presentation to Engineers Australia on June 6th 2006.

### Future

Building on the foundation program this year, 2007 will usher in enhanced inter-institutional outreach communication and a growing collection of communications resources to support the development and best practice of outreach centre-wide. These will support increasing student confidence and participation in the school talks program and other planned initiatives.



▲ The CUDOS stall at Science EXPOsed in October.