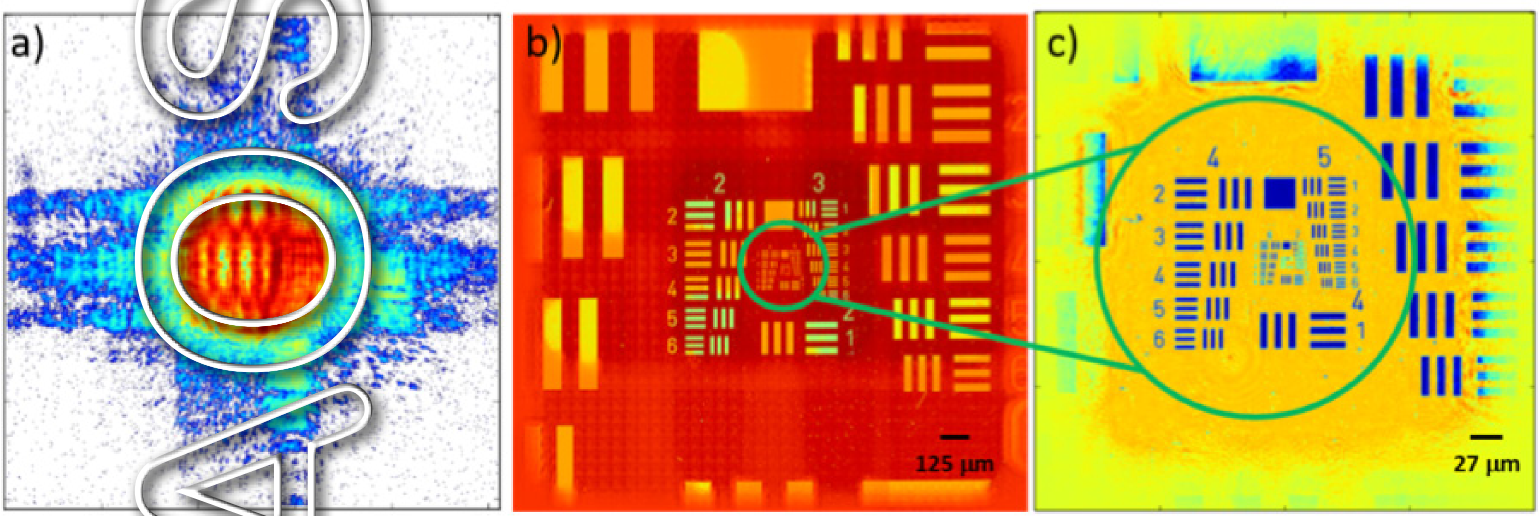
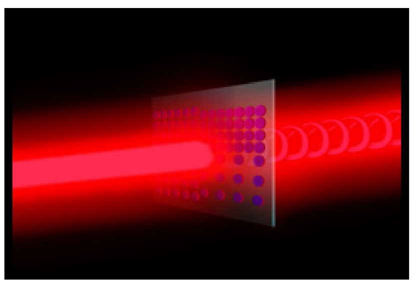
AOS News

Volume 30 Issue 3
October 2016
ISSN 1832-4436
Registered by
Australia Post
Publication No:
233066 / 00030



AUSTRALIAN OPTICAL SOCIETY

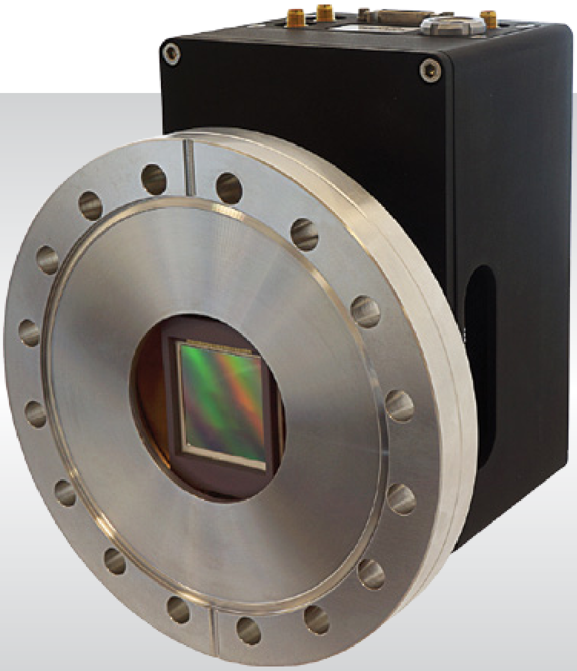


Raptor photonics

Eagle XO

Open Front, Direct detection CCD

High resolution soft X-ray scientific imaging



Key Features and Benefits

Ultimate Sensitivity Performance

- Open front end
  CF152 (6”) flange for direct interfacing to vacuum chambers
- Deep cooled using Thermoelectric cooler (TEC)
  Minimise dark current and enable long exposure
- Back Illuminated with no coating
  Optimises sensitivity and large field of view imaging
- 13.5µm x 13.5µm pixels
  Enables ultra sharp image resolution and high dynamic range
- *Ideal for Synchrotron and beamlines, X-ray diffraction, X-ray spectroscopy, plasma physics and holography/lithography*

NINOX SWIR 640

Low-noise, cooled digital InGaAs

High resolution VIS-SWIR imaging

Key Features and Benefits

The Best Performing SWIR Camera in the World!

- 640 x 512 array with 15 µm x 15 µm pixel pitch
  Enables highest resolution VIS-SWIR image
- Cooled VIS-SWIR technology
  Cooled to -20°C. Enables low dark current and longer exposure
- On-board intelligent 3-point NUC
  Enables highest quality images direct from the camera
- $<50e^{-}$ noise in High Gain with 70dB dynamic range
  Enables highest VIS-SWIR detection limit, capturing both bright and dark portions simultaneously
- *Ideal for astronomy, beam profiling, hyperspectral imaging, semiconductor inspection, solar cell inspection, thermography and microscopy*

Lastek Photonics Technology Solutions
sales@lastek.com.au | www.lastek.com.au

Radiant Zemax

About ZEMAX

ZEMAX is the Optical Design Software that optical engineers and designers around the world choose for lens design, illumination, laser beam propagation, stray light, freeform optical design and many other applications.
ZEMAX leads the industry in technical power, ease of use and proven accuracy.

Large Light Source Performance Characterization

PM-NFMS™

Key Features

-Full ±90° range of motion in two axes
-Laser alignment tool provided to minimize set-up error
-Two sizes of goniometer, with fully automated measurement control
-Compatible with any ProMetric® Imaging Colorimeter or Photometer
-Near-field to far-field extrapolation integrated into analysis software.

OpticStudio 14™
Optical and Illumination Design Software

Zemax

Optics Studio 14

Maximize Productivity with OpticStudio

OpticStudio is the pinnacle of optical and illumination design software, an evolution engineered by Zemax. The intuitive user interface combined with a comprehensive array of features and unmatched functionality make OpticStudio the preferred design platform for engineers, researchers and designers around the world. Built on Zemax's core physics engine, OpticStudio is fast, reliable and accurate. Innovate with speed and confidence using OpticStudio from Zemax.

Zemax engineered three separate editions of OpticStudio – Standard, Professional and Premium, so you can choose the edition with the features you need.

OpticStudio Highlights:

-Design almost any optical or illumination system
-Configurable workspace with quick-nav ribbon menus
-Fastest simulation, analysis and optimization available
-Precise design validation with cutting edge 2D/3D charting tools
-CAD-like design visualization with interactive 2D/3D modeling
-Largest library of resource materials and design models available

WAVELENGTH OPTO-ELECTRONIC

BLK 2, Bukit Batok St.24, #06-03, Skytech Building, Singapore 659480

Tel: 65-65649624
Fax: 65-65643862
Email: info@wavelength-tech.com
Website: www.wavelength-tech.com

Operation Hours
Monday - Friday : 8:45 am - 6:00 pm
Saturday : 9:00am - 1:00pm (Every two weeks)
Sunday & Public Holiday : Closed

AUSTRALIAN OPTICAL SOCIETY ABN 63 009 548 387

AOS News is the official news magazine of the Australian Optical Society. Formed in 1983, the Society is a non-profit organisation for the advancement of optics in Australia. Membership is open to all persons contributing to, or interested in, optics in the widest sense. See the back page (or the AOS website) for details on joining the Society.

Submission guidelines

The AOS News is always looking for contributions, especially from AOS members. Here is a short summary of how to make a submission.

Call for submissions!

Please consider writing something for the next issue.
We are looking for:

Scientific articles on any aspect of optics

Review articles on work in your lab

Conference reports from meetings you attend

Articles for the Optics in Everday Life section

General interest articles

How can you submit?

► The easiest way is by email. We accept nearly all file formats. (Famous last words!).

► Submitted articles will be imported into an Adobe InDesign file. It is best if the diagrams and other graphics are submitted as separate files. All common graphics formats are acceptable, but the resolution must be in excess of 300d.p.i.. Be aware that all colour diagrams will be rendered in grayscale, so if you do use colours, choose colours that show up well in grayscale.

► When using Greek letters and mathematical symbols, use font sets such as Symbol or MT Extra. Please avoid using symbols that are in Roman fonts, where the Option or Alt key is used; e.g. Opt-m in Times font on the Mac for the Greek letter mu.

► If using TeX, use a style file similar to that for Phys Rev. Letters (one column for the title, author and by-line, and two for the main body). The top and bottom margins must be at least 20mm and the side margins 25mm. Submit a pdf file with the diagrams included (no page numbers), as well as copies of the diagrams in their original format in separate files.

► If using a word processor, use a single column. If you do include the graphics in the main document, they should be placed in-line rather than with anchors, but must be submitted separately as well.

What can you submit?

- Scientific Article: A scientific paper in any area of optics.
- Review Article: Simply give a run down of the work conducted at your laboratory, or some aspect of this work.
- Conference Report
- General Interest Article: Any item of interest to members such as reports on community engagement, science in society, etc.
- Article for Optics in Everyday Life section: An explanation of the optics behind any interesting effect, phenomenon, or device.
- News Item
- Obituary
- Book Review
- Cartoon or drawing
- Crossword or puzzle

Reviewing of papers

On submission of a scientific or review article you may request that the paper be refereed, and if subsequently accepted it will be identified as a refereed paper in the contents page. The refereeing process will be the same as for any of the regular peer reviewed scientific journals. Please bear in mind that refereeing takes time and the article should therefore be submitted well in advance of the publication date.

Submission Of Copy:
Contributions on any topic of interest to the Australian optics community are solicited, and should be sent to the editor, or a member of the AOS council. Use of electronic mail is strongly encouraged, although submission of hard copy together with a text file on CD will be considered.

Advertising:
Potential advertisers in AOS News are welcome, and should contact the editor.
Rates: Colour pages $345, Black and White pages $175, with a surchargee for choosing a spefic page for the ads (rates excl. GST). 1-2 Black and White pages in the main body of the newsletter are free to corporate members.

Copy Deadline
Articles for the next issue (December 2016) should be with the editor no later than 21 November 2016, advertising deadline 14 November 2016.

Editor
Jessica Kvansakul
La Trobe Institute for Molecular Science
La Trobe University
Melbourne VIC 3086
jk.aosnews@gmail.com

Australian Optical Society website:
http://www.optics.org.au

- News
- Membership
- Optics links
- Prizes/awards
- Conferences
- Jobs/Scholarships
- Affiliated societies
- ...and more

October 2016 Volume 30 Number 3

Articles

Departments

Cover Pictures:

- Upper: A laser show was presented at the Museum of Tropical Queensland, Townsville, on 17 August during science week as part of a series highlighting the story of Aleksandr Prokhorov, the Nobel Laureate who co-invented the laser and was born in regional Queensland. Over 300 people attended the event, see page 14.
- Lower: Images taken with an optical diffractive microscope capable of quantifying stress within biological samples, see page 26. a) Diffraction data collected, b) reconstructed amplitude of large field of view with a grid scan, c) smaller field of view, higher resolution Fermat scan.
- Insets (left to right)
    - Optics v2.0: A Huygens' metasurface consisting of arrays of silicon nanodisks with various lattice periodicities can be used to turn a Gaussian beam into a vortex beam, see page 17. Image credit: Geo Chong.
    - Opposition Leader Bill Shorten was one of the speakers at the Science meets Parliament event in Canberra in March, see page 11. Photo by Mark Graham, courtesy of Science meets Parliament 2016.

AUSTRALIAN OPTICAL SOCIETY

AOS Executive

PRESIDENT
Stephen Collins
Eng & Sci - Footscray Park campus
Victoria University, PO Box 14428
MELBOURNE VIC 8001
Telephone: 03 9919 4283
stephen.collins@vu.edu.au

VICE PRESIDENT
Simon Fleming
School of Physics (A28)
University of Sydney
Institute of Photonics and Optical Science, SYDNEY NSW 2006
Telephone: 02 9114 0581
Fax: 02 9351 7726
simon.fleming@sydney.edu.au

PAST PRESIDENT
Ann Roberts
School of Physics
University of Melbourne
MELBOURNE VIC 3010
Telephone: 03 8344 5038
Fax: 03 9347 4783
ann.roberts@unimelb.edu.au

HONORARY SECRETARY
Dragomir Neshev
Nonlinear Physics Centre, RSPE
Australian National University
CANBERRA ACT 2601
Tel: 02 6125 3792
Fax: 02 6125 8588
dragomir.neshev@anu.edu.au

HONORARY TREASURER
Baohua Jia
Centre for Micro-Photonics
Swinburne University of Technology
VIC 3122
Tel: 03 9214 4819
Fax: 03 9214 5435
bjia@swin.edu.au

AOS Councillors

Ken Baldwin
Atomic and Molecular Physics Labs
ANU, RSPSE
Canberra ACT 0200
Tel. (02) 6125 4702
Fax. (02) 6125 2452
kenneth.baldwin@anu.edu.au

Maryanne Large
Innovation and Commercialisation
Faculty of Science
University of Sydney
Sydney NSW 2006
Tel. (02) 9114 0850
maryanne.large@sydney.edu.au

John Harvey
Department of Physics,
University of Auckland,
Private Bag 92019,
Auckland 1010, New Zealand
Tel: (+64 9) 373 7599
Fax: (+64 9) 373 7445
j.harvey@auckland.ac.nz

Ben Eggleton
Director, CUDOS
School of Physics,
University of Sydney
Sydney NSW 2006
Tel: 02 9351 3604
Fax: (02) 9351 7726
egg@physics.usyd.edu.au

Halina Rubinsztein-Dunlop
Department of Physics,
University of Queensland,
Brisbane, QLD 4072
Tel: (07) 3365 3139
Fax: (07) 3365 1242
halina@physics.uq.edu.au

Robert McLaughlin
Chair of Biophotonics
Centre for Nanoscale Biophotonics
University of Adelaide, SA 5005
Tel: 08 8313 9942
Fax: 08 8313 4380
robert.mclaughlin@adelaide.edu.au

Peter Veitch
Department of Physics,
University of Adelaide, SA 5005
Tel: (08) 8313 5040
Fax: (08) 8313 4380
peter.veitch@adelaide.edu.au

John Grace
INDUSTRY REPRESENTATIVE
PO Box 958
NEWPORT BEACH NSW 2106
Tel:(02) 9979 7646
Fax: (02) 9979 8207
johng@raymax.com.au

Affiliates: OSA and SPIE

Corporate Members

AFW Technologies Pty Ltd
BAE Systems
Coherent Scientific Pty
CUDOS
EzziVision Pty Ltd
Laser SOS Ltd
Lastek Pty Ltd
Photon Scientific
Raymax Applications
Warsash Scientific Pty
Wavelength Optoelectronic

President's Report

This time I necessarily need to commence my report on the sad news, as reported briefly in the previous AOS News, of the death of John Love. I first interacted with him back when ACOFT, the conference series he was associated with throughout his career, was being backed by the then IREE. His tireless efforts to champion guided-wave optics through his own University, ANU, and through collaborations with colleagues in other universities, led the AOS to make him a Life Member of AOS in 2009. He will be greatly missed, as was evident at the recent ACOFT, where a special tribute lunch was held for him. Quite a few people made an effort to meet with him in the last few months of his life, and I and my family enjoyed afternoon tea at his suburban Canberra home last Easter, including a look at the train set that occupied his garage!

Last month the OSA Photonics and Fiber Technology Congress was held in Sydney. The venue was in the centre of Sydney and, amongst other things, featured the distinct rumble of trains passing underneath, as it was near one of the tunnel entrances for Sydney's underground! The conference, that combined the BGPP (Bragg Gratings, Photosensitivity and Poling in Glass Waveguides), NP (Nonlinear Photonics) and 41st ACOFT conferences attracted around 300 delegates and I thank Ben Eggleton, the Congress Chair, and the many others who worked with him. At the dinner two of AOS' recently announced Life Memberships were presented to Jim Piper and Brian Orr. The meeting of the ACOFT Steering Committee held during this Congress, was particularly timely with the passing of John Love, which means that the membership of this Committee (which includes representatives of Engineers Australia) needs some modifications to ensure that current strong supporters of ACOFT are included.

Elsewhere in this edition of AOS News I have written about recent National Science Week activities marking the centenary of the birth of Aleksandr Prokhorov, in the Atherton Tablelands region. At the heart of this was the Laser Show, a two-person show, presented by Prof Hans Bachor (of ANU) and Patrick Helean (of Questacon - the National Science and Technology Centre, Canberra), which is a marvellous combination of trying to explain science and good humour. Public events in Townsville, Cairns and Atherton and private shows in schools were seen by around 800 people in total. At the AIP Congress in Brisbane there will be a further marking this centenary (in conjunction with the OSA, which is also marking its centenary this year). Of course, in Russia, the centenary was also celebrated, at the Laser Optics Conference (27 June - 1 July in St. Petersburg) and at the Russian Academy of Sciences in the following week.

Also earlier in September the ARC announced nine new Centres of Excellence. Whilst acknowledging that there were disappointments for some I congratulate AOS Colleagues who are part of one or other of these, e.g. ARC Centre of Excellence for Gravitational Wave Discovery, ARC Centre of Excellence for Engineered Quantum Systems, ARC Centre of Excellence in Future Low Energy Electronics Technologies.

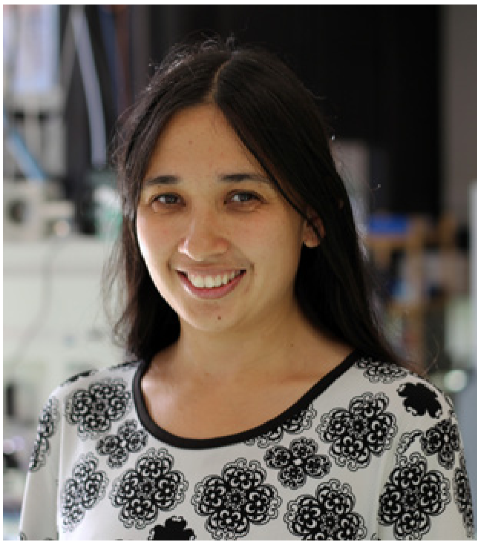
In recent days the Council has discussed and agreed upon a Policy on Equity and Diversity, which begins by noting "The Australian Optical Society (AOS) is committed to the principles of equity and diversity. These principles are integral to our desire to promote excellence and fairness, and to encourage interest in optics across the community." and stating "conferences and events associated with the AOS must also be run according to these principles." Similar policies have been adopted by other professional societies. Further details will be given at the AGM and in a future AOS News.

As the end of the year draws nearer I trust many AOS members are planning to participate at the AOS annual meeting to be held 4-8 December in Brisbane, as part of the 22nd Australian Institute of Physics Congress (in conjunction with the 13th Conference of the Association of Asia-Pacific Physics Societies). Halina Rubinsztein-Dunlop and the current AIP president, Warwick Couch, are Conference Co-Chairs. The next AOS AGM will be held during the Congress; please watch out for further details. The AOS Council is working towards holding another ANZCOP (incorporating ACOLS and ACOFT) at in the resort town of Queenstown on the South Island of New Zealand during the week commencing 4 December 2017.

As this will be my last column, I would like to acknowledge the hard work of the members of the Council, particularly our Secretary, Dragomir Neshev, and Treasurer, Baohua Jia. AOS is a small organisation, and its operation is only possible through the contributions of members who give of their time and energy for our profession. The new website has eventuated mainly through such efforts. Many thanks also to colleagues who have been involved in organising our highly successful conferences during my term as President and those who are currently working hard on upcoming events. Jessica Kvansakul, the editor of the AOS News, continues her excellent work in the regular production of the News over the year. Finally, I wish all AOS members well for their ongoing work and ask that you please consider standing for Council or finding other ways to volunteer in ways that will help support the aims of our Society.

Stephen Collins
AOS president

Editor's Intro



Welcome to another issue of AOS News. We have a range of articles, with reports on activities taking place during National Science Week to remember Aleksandr Prokhorov and from the Science Meets Parliament event in Canberra. There is also an item about a lecture series at QUT as part of the OSA centennial celebrations and an article from the winner of the AOS 2015 postgraduate student prize, Katie Chong, on shaping light with optics. Other items in this issue include an article on using diffractive imaging in stress analysis and our 'Optics in Everyday Life' section looking at colour vision deficiencies. I hope you enjoy reading them all. As usual, please let me know if you have any suggestions for anything you would like to see in AOS News or have any articles or other items you would like to submit.

A recent report from The Grattan Institute claims there are more science graduates now but not enough jobs available for them when they graduate. The report highlights the fact that in 2015 only half of those science graduates looking for full time work had been successful within four months of completion, well below the average for all graduates. Andrew Norton, the Grattan Institute Higher Education Program Director is concerned there are too many people studying science thinking this will lead to a job in the field when this is unlikely to be the case. This is not a new suggestion, as he has said previously that the push from the government and chief scientist for more people trained in STEM subjects could mislead students into thinking there will be jobs easily available. In some ways he has a point and there is often concern raised about the lack of job security and future prospects at all levels of science as well as the fact that there are many more PhD students and postdocs than academic positions available. In response to an older article from Andrew Norton, many commenters pointed out that often people study science as this is what they are interested in and passionate about, rather than considering their job prospects. Also, you can't compare employment for those taking courses towards specific careers such as medicine, dentistry and nursing with general areas of study such as science. We don't want those with an interest turning away from studying STEM subjects just because they listened to those saying they won't get a job. Employment for those completing a degree is still improved and STEM PhD graduates generally earn higher salaries than graduates from many other areas within five years. There are improvements that should be made and that are starting to take place in many universities where both undergraduate and postgraduate students are offered industry placements and training in additional skills that will be useful in a more general setting.

A large part of the problem is that skills gained in a science degree don't receive appropriate recognition. In other countries there is a much wider range of industries that routinely accept science graduates as they value the skills in logic, lateral and critical thinking and problem solving, whereas this is not the case in Australia. I think those in government who suggest we need more STEM literacy and training are correct, but they need to do more to encourage the utilisation of these graduates in the wider community. It is great to hear stories of people who used their STEM training to develop an idea and start a successful company, but we can't expect everyone to be able to do this. Not everyone will end up running a lab or founding a company, but this doesn't mean that all the years of training should have to go to waste. Ideally there would be more research positions available for those who would like to stay at the postdoc level, which is currently not possible. At the moment there are also only a limited number of industry positions available for these people to transfer into, so they often end up leaving the sector entirely.

Working on all sides of the problem seems essential. It is clear that any approach must involve collaboration and target different aspects to ensure Australia isn't left behind in the innovation revolution. At the early stage we need school students to have an idea of the contributions of science and technology to society and their everyday lives as well for students to end up with basic scientific and mathematical literacy. For this we could do with changes in the school system and to have more STEM-trained teachers at both primary and secondary levels. At the university level we could do with more programs like the Industry Mentoring Network in STEM that matches PhD students with industry mentors, giving students the experience and allowing potential employers to see the skills STEM students can bring. Students themselves could also improve their prospects by having a career development plan, tapping into leadership and volunteering opportunities and working on building a network of useful contacts whilst pursuing their PhD. At the other end we need businesses to value the skills STEM graduates have and more companies doing R&D. If the government wants an actual innovation economy to develop in Australia they will need to foster an environment that nurtures and encourages innovation. Planning for a good balance of researchers across career stages is vital, along with the government investing more in science and research and showing long term commitment. Alongside this, improvements to incentives for companies to undertake research, taking more risks with research funding and having incentives for universities to collaborate with industry have also been identified as key areas. The National Innovation and Science Agenda aims to embrace some of these ideas, so hopefully it will be successful.

Jessica Kvansakul
Editor

OSA Centennial Year Celebrated with Lecture Series at QUT

The OSA Student chapter at Queensland University of Technology organised a lecture series to mark the Centenary year of the Optical Society, aiming to highlight applications of optics.

by Samrat Sakar, Uchechukwu L Osuagwu and Amithavikram R Hathibelagal

The graduate students in the school of Optometry and Vision Science at Queensland University of Technology (QUT) have an immense passion in exploring the application of optics in their research activities. With this passion, an Optical Society (OSA) QUT student chapter was established in the year 2012. This year the QUT OSA student chapter organised their first ever OSA lecture series to mark the Centenary year of the Optical Society. This event was a joint collaboration between the QUT OSA student chapter and the QUT school of Optometry and Vision Science. The objective of the event was to educate and spread awareness of the wide field of applications of optics and light based technologies in science, engineering and health research. In addition to that, we also wanted to highlight the achievements of our team and the challenges faced by the chapter. These were made clear to the audience in the Chapter President's welcome speech.

The event witnessed presentations from two notable speakers and was held at the Institute of Health and Biomedical Innovation building on 20th April 2016. The first speaker, Associate Professor Ian Cowling is from the School of Chemistry, Physics and Mechanical Engineering in the Science and Engineering Faculty at QUT and has worked as an academic at QUT for more than 30 years. His specialty is the detection and measurement of light. Associate Professor Cowling leads the QUT Lighting team in a range of educational, consulting, design and development projects. He set up the NATA accredited QUT Photometric Laboratory in the early 1990s. He established the post-graduate lighting course at QUT in 2004 and oversaw its extension as a course in Hong Kong in 2005. Recently he was awarded a large grant to work on Daylighting design, and he has worked on ultraviolet doses to the eye.

Associate Professor Cowling is well-known for his industrial and commercial experience and works on helping research students in connecting their research work with the outside world. He has co-authored many publications and recently his work on "Discomfort glare in open plan green buildings" was published in the Journal of Energy and Buildings. Associate Professor Cowling has had considerable experience speaking at both local and international scientific conferences and in his speech titled "How best to collaborate with Industries", he talked about how he was able to maintain and establish a photometric laboratory and also how to successfully collaborate with industries. His talk provided useful insight to the students who were interested in the same topic.

Speakers with members of the QUT OSA student chapter.

The second speaker Dr Atanu Ghosh is a Clinical Research Fellow in the Contact Lens and Visual Optics Laboratory, School of Optometry and Vision Science, Faculty of Health, QUT. Dr Ghosh obtained his PhD degree from QUT for his work on "Optical and biomechanical factors associated with near work and myopia" in 2012. His work provided important insights into the potential role of near work in the development of myopia in children. In 2014, Dr Ghosh joined the University of Rochester, New York for a post-doctoral fellowship in which he investigated the effect of blur adaptation on human parafoveal vision using an Adaptive Optics Vision Simulator. His research interests include visual optics and myopia, adaptive optics and visual psychophysics, contact lens application in presbyopia and astigmatism and biomechanical aspects of myopia. He has published in various vision and optics journals, and has delivered invited lectures at various symposia. Dr Ghosh's presentation during this event was on the application of adaptive optics in the investigation of vision. He shed light into his two year experience at the University of Rochester, and he demonstrated how Adaptive optics technology has transformed the world of ocular imaging including applications in retinal photoreceptor imagery and in the study of myopia development/progression.

This first event from the QUT OSA student chapter was well appreciated by the audience. There were 40 attendees and we expect it will grow for future events. The audience included undergraduate students, postgraduate students, and faculty staff from QUT School of Optometry and Vision Science, as well as students from the University of Queensland (UQ) OSA student chapter. The audience also had an opportunity to have a one-on-one conversation with the guest speakers after the event which

QUT OSA student chapter members.

was followed by lunch and refreshments sponsored by the student chapter.

There will be at least 2 lecture series per year. This event would not be possible without generous support from an Optical Society OSA Centenary Grant that was awarded to our chapter. We would also like to extend our gratitude to QUT School of Optometry and Vision Science and the Institute of Health and Biomedical Innovation at QUT for their help in organising the event.

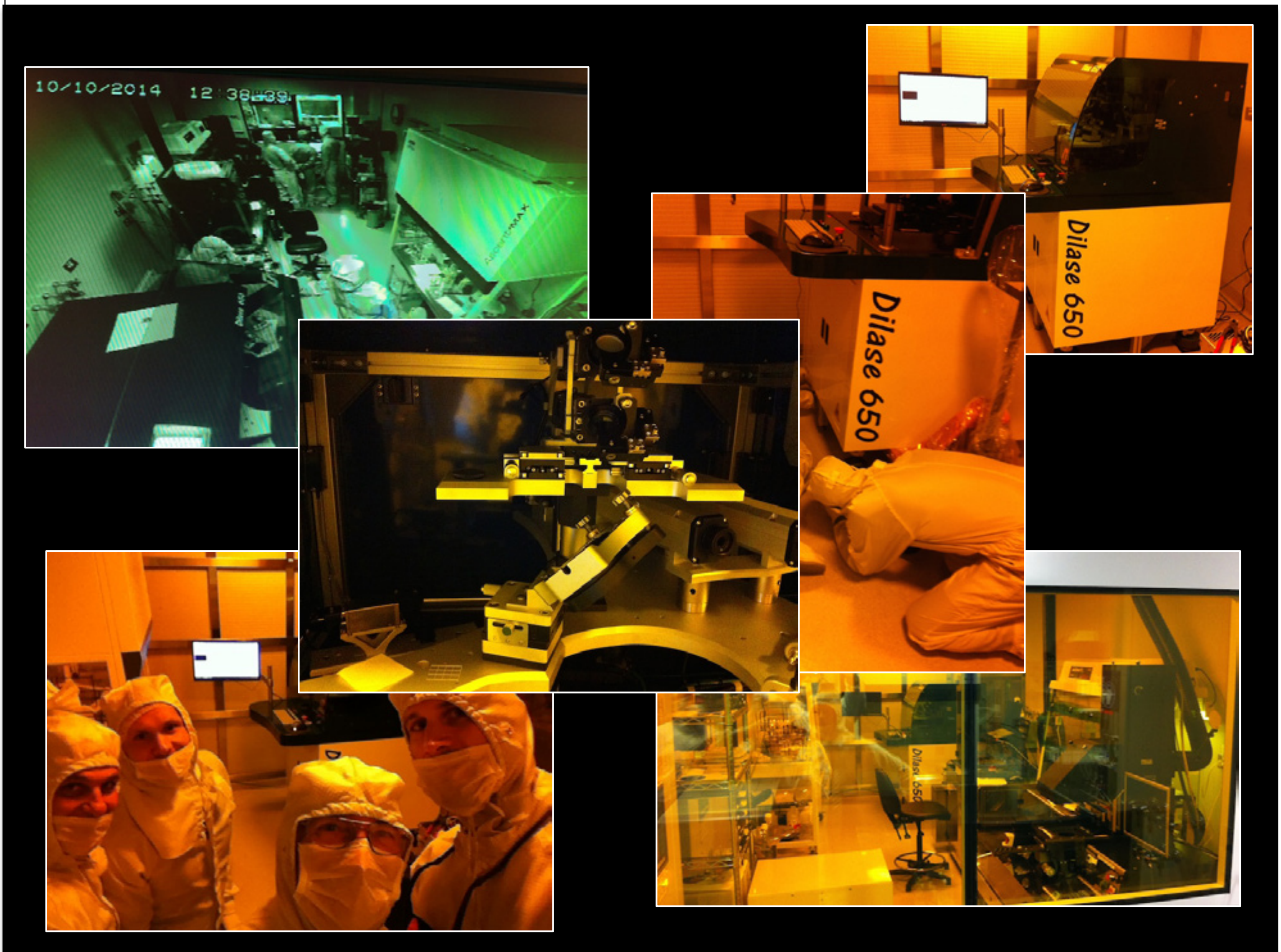
About us: The QUT OSA student chapter was established in 2012 through the passion of its first President Dr Adnan Khan. The association is run by Optometry graduate students. Professor David Atchison, the head of the Visual and Ophthalmic Optics Research Group, Institute of Health and Biomedical Innovation (IHBI) is the advisor of the chapter. Dr Uchechukwu Levi Osuagwu, PhD student at IHBI and QUT School of Optometry and Vision Science, is the current Chapter president. He coordinates the activities of the chapter, keeps deadlines and inspires the chapter members to get involved.

The QUT OSA student chapter won the prize for best poster presentation at the 2016 Student Leadership Conference at Frontiers in Optics in Rochester, New York for a poster outlining the work of the chapter, including this lecture series.

Samrat Sakar and Uchechukwu Osuagwu are with the Visual and Ophthalmic Optics Laboratory, and Amithavikram Hathibelagal is with the Visual Science and Medical Retina Laboratories. All are PhD students at the Institute of Health and Biomedical Innovation, School of Optometry and Vision Sciences, Queensland University of Technology, Brisbane.

THE DILASE RANGE

KLOÉ



Direct Laser Photolithography Systems

Kloé – Audacity and difference in direct laser writing with innovative patterning for microfluidics, microelectronics, MEMS, photonics, micromechanics, surface structuration and high aspect ratio structuration.

Raymax Applications Pty Ltd
info@raymax.com.au

Reflections on Science Meets Parliament

by Daniel Shaddock

All photos are by Mark Graham, courtesy of Science Meets Parliament 2016.

Science Meets Parliament is an annual two-day event held in Canberra hosted by Science and Technology Australia to bring together scientists, policy makers and elements of the media to share ideas and perspectives.

The 16th Science Meets Parliament event kicked off on a sunny March morning at the Hotel Realm, a short stroll from Parliament House. It was opportune timing for this event, less than 6 months after a change of Prime Minister and hot on the heels of the National Innovation and Science Agenda that put science and ideas back in the national spotlight.

The 2016 Science Meets Parliament attracted more than 200 scientists from Australian universities, government agencies and scientific societies. The first day was basically a boot camp to prepare scientists for day two, when we would get a few minutes of precious face-time with politicians. We were given a crash course in science communication, public policy formation and working with the media. The impressive line-up of speakers included well known media pros such as Alison Carabine and Paul Bongiorno, public policy influencers like Dr Subho Banerjee, and eminent scientists such as Prof Emily Banks from ANU and Emeritus Prof Jim Piper, now the President of Science & Technology Australia. Scientists were showered with advice: do your homework before the meeting, don't talk about funding, don't whinge or complain, follow your parliamentarian on twitter, engage interest in your research, articulate why it is important.

In the afternoon, we were encouraged to put this advice into practice and split into groups to hone our two minute pitches to parliamentarians. As many of the attendees realised, it is hard (even painful) to distil a lifetime's research down to a short, casual conversation. Fresh from our grooming, our minds brimming with advice after an intense day, we headed to the Gala dinner at Parliament House for our first interaction with the second half of the Science Meets Parliament. The dinner guests included not just politicians but senior public servants from relevant government departments and a who's who of eminent Australian scientists. After dinner speeches by Industry, Innovation and Science Minister Christopher Pyne and the Opposition Leader Bill Shorten underlined the value both parties place on science in the context of the National Innovation and Science Agenda and the importance of pure research to complement innovation.

On day two, Science Meets Parliament moved to Parliament house, and attendees were given schedules to meet with politicians throughout the day in addition to other activities including the National Press Club lunch and numerous expert panel discussions. It was a dynamic day. With Parliament sitting we were warned that schedules were subject to change at any time, and it was a test of the organisational skills of the Science Meets Parliament helpers to get people in the right place at the right time to make the most of any meeting opportunities.

Daniel Shaddock at one of the sessions on Day 1 of Science Meets Parliament.

Opposition Leader Bill Shorten and scientists at the Gala dinner.

What did I get out of Science meets parliament? In a nutshell, I lost a lot of my cynicism about the relationship between science and policy makers. All of the politicians I met cared very deeply about making a positive difference and were eager to learn how they can help scientists be more effective. I was very lucky in my parliamentarian draw, and received a generous amount of face time with Assistant Minister for Innovation Wyatt Roy, sat next to former Chief Scientist Ian Chubb at dinner, had coffee with Nobel Laureate Brian Schmidt, talked gender equity issues with ARC CEO Aidan Byrne, chatted with Bill Shorten about gravitational waves, and even talked to Malcolm Turnbull about our startup Liquid Instruments. And the fun didn't end there.

In the months following Science Meets

A group of delegates attending Science Meets Parliament talked to Prime Minister Malcolm Turnbull about their research.

Parliament I have had several follow-up email exchanges with Wyatt Roy, spent an hour on the phone with the Chair of Innovation Australia, Bill Ferris, and hosted a visit to my lab from our incredibly engaged Chief Scientist Alan Finkel. I was struck by how knowledgeable and informed many of the politicians were about detailed scientific issues. Everybody's mileage will vary, but for me Science Meets Parliament was an incredibly useful experience, well beyond my expectations. I would like to thank Catriona Jackson, CEO of Science and Technology Australia for an outstanding job pulling together the event. If you get the chance to go to Science Meets Parliament, grab it with both hands. It is a unique opportunity and provided me with a new found perspective on the role of science in our society.

Professor Daniel Shaddock is with the Department of Quantum Science, Research School of Physics and Engineering, The Australian National University.

Greens MP Adam Bandt and delegates discuss how science and politics mix at the final session.

National Science Week 2016 - "Prokhorov Centenary"

by Stephen Collins

In 2016 Australian the Optical Society (AOS) partnered with the Australian Institute of Physics (AIP) to deliver a National Science Week activity "Prokhorov centenary: far-north-Queensland-born physics Nobel Laureate", funded by an Australian government grant [1].

The series of public presentations, focussed on the laser show, highlighted the curious story of Aleksandr Prokhorov, born in 1916 in the Atherton Tablelands, who subsequently returned with his parents to their Russian homeland [2]. As noted last year, not many Australians know that one of the co-inventors of the laser was born in and attended school in regional Queensland. This centenary was a good follow-up to the wide range of science outreach activities across Australia that AOS (and other societies) funded to highlight the International Year of Light in 2015, and built on previous activities conducted under the banner "Laserfest" in 2010 (commemorating 50 years of the laser).

Prior to Science Week, at the time of Prokhorov's actual birthday, press releases were issued, and picked up by some media outlets, e.g. ABC Radio National. At that time Prokhorov's former primary school, Butchers Creek State School, had a birthday party, and this was reported by the local newspaper, as shown in Figure 1.


TABLELANDER

PHOENIX RISES FOODWORKS TO RE-OPEN BY XMAS

STREET WATCH KEEPING OUR COMMUNITY SAFE

POWER UP GET CYCLING WITH YOUR BUDDIES

Prokhorov centenary

Nobel Prize-winning scientist an inspiration

Figure 1. From the front page of the Tablelander, 19 July.

During Science Week, 15-20 August, almost 800 school children and members of the public in Townsville, Cairns and Atherton enjoyed the story of their local Nobel hero, Aleksandr Prokhorov, and his role in the invention of the laser. Through the interactive "laser show" these audiences learned about the science of lasers and the contributions lasers have made to Australian industry and our daily lives. The show was delivered in 5 locations, each of which required particular negotiations with local stakeholders. The largest single audience was at the Museum of Tropical Queensland (located in Townsville), a special "Drones, Droids and Lasers" event on 17 August, which was a huge success with over 300 people attending on the night (many of whom were paid ticket holders), as shown in Figure 2.

In several locations there was an opportunity for attendees to participate in a "do-it-yourself hologram" activity, with many children returning home with their own hologram. It was a bit disappointing though that the two other publicised public events (in Cairns and Atherton), that were free, had a much smaller attendance. Reasons are probably related to the timing or location (e.g. the Cairns event was at JCU, which is somewhat removed from the centre of Cairns). The Atherton event (see Figure 3) was championed by an enthusiastic physics teacher, and we were pleased that the Mayor of the Tablelands Regional Council attended.

A great highlight was the 'private' delivery of the show in Prokhorov's former primary school, Butchers Creek State School, to about 20 students, see Figure 4. The students were well aware of this amazing connection to their school, and I am certain they had never had a science outreach presentation at their school. A few days later the Principal told me that the students were still talking about it!

The events gained publicity in the region, including a double page article in the "Tablelander", reproduced in Figure 5, and the aim of ensuring greater local knowledge of Prokhorov was achieved. The presenters were pleased that the Mayor of the Tablelands Regional Council recognised the need for the region to have

Figure 2. Event at the Museum of Tropical Queensland, 17 August (the visit of Einstein in the right-hand photo should be noticed!).

Figure 3. At Atherton State High School, 20 August (the author giving a brief overview of Prokhorov's life mid-way through the laser show).

Acknowledgement

Newspaper copies and photographs used with permission.

References

[1] National Science Week - administered by Questacon - The National Science and Technology Centre, A Division of the Commonwealth Department of Industry, Innovation and Science.

[2] SF Collins, "Aleksandr Prokhorov, Australian-born Nobel Laureate in Physics", Australian Optical Society News Vol. 29, no. 1, March 2016, pp. 17-18.

Stephen Collins is with Victoria University.

some sort of public artwork or monument as an ongoing reminder of Prokhorov.

I would like to thank Hans Bachor and Patrick Helean (of Questacon) for their multiple presentations of the laser show and Margaret Wegener for arranging "do-it-yourself holograms" and giving their time and very considerable energy to this project.

Figure 4. At Butchers Creek State School, 19 August.

12 NEWS — TUESDAY AUGUST 30 2016 FACEBOOK.COM/THETABLELANDER

PROKHOROV CENTENARY

Atherton tops in science

Scientist honoured in laser spectacle

Lasers in use everywhere

The kid from Butchers Creek

SOURCES CONSULTED

FACEBOOK.COM/THETABLELANDER TUESDAY AUGUST 30 2016 — NEWS 13

PROKHOROV CENTENARY

Tablelands recalled with 'light and pleasure'

Science behind the laser

What's in a name?

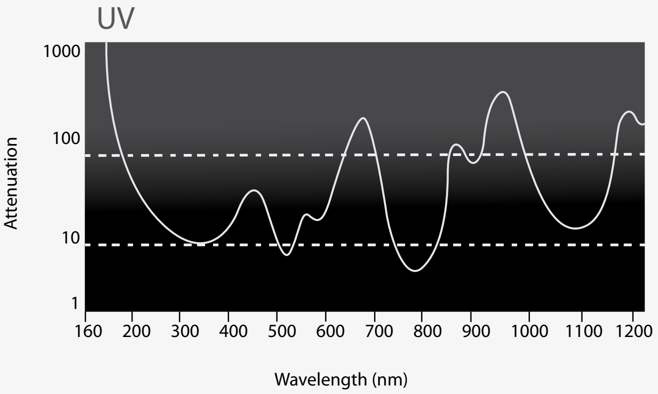
Figure 5. From The Tablelander, 30 August.

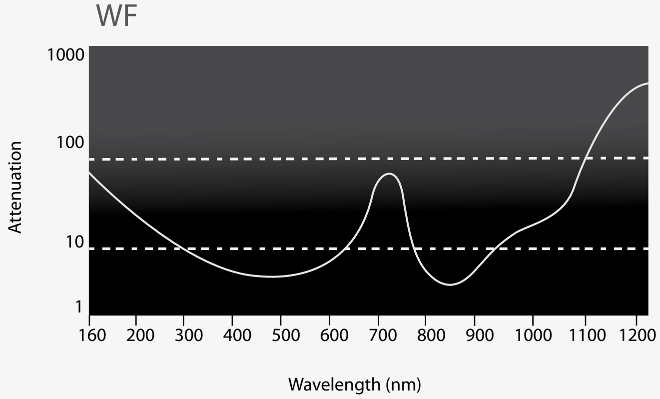
Fibre Optic & Photonic products

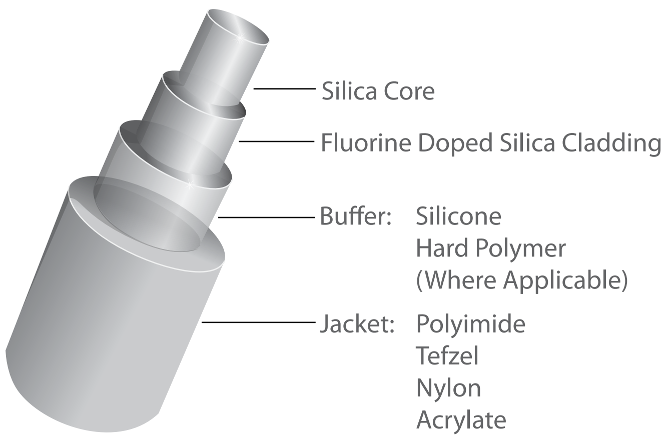
Large diameter core multimode fibre cable assemblies for broad UV/VIS/NIR spectral range

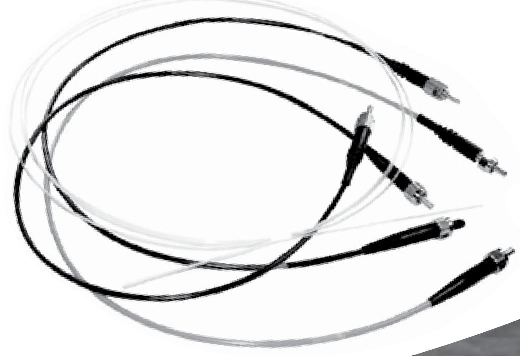
AFW supplies optical fibre and assemblies for various industry and research applications.
We offer several fibre core sizes terminated with SMA, ST or FC type connectors.

Applications	Features
Spectroscopy	Broad UV / VIS / NIR spectral range
Sensors	Low NA 0.12, standard NA 0.22
UV photolithography	Pure silica core and doped fluorine silica cladding
Laser welding / soldering / marketing	Core/cladding 105/125, 100/140, 200/220, 400/440, 600/660, 800/880 um
Laser delivery	Jacketed with 3mm PVC material and connector boots behind the connector
Nuclear plasma diagnostics	
Analytical instruments	1 to 3 meter or custom lengths
Laser diode pigtailing	FC, SMA 905 or ST type connectors
Semiconductor capital equipment	FC, ST or SMA adaptors









AFW
AFW Technologies

Phone: +613 9702 4402
Email: sales@afwtechnology.com.au
www.afwtechnology.com.au

Shaping Light with Optics v2.0

Efficient wavefront control can now be done with flat and low loss all-dielectric metasurfaces, providing a route to ultra-thin nanophotonic devices. Katie Chong is the recipient of the AOS 2015 Postgraduate Student Prize.

by Katie Chong

The ability to control and shape light is tremendously important to us in everyday life as well as in scientific research. For example, by controlling the convergence and divergence of light using lenses, custom-made eye glasses can be made for people with refractive errors, such as myopia and astigmatism. On the other hand, microscopes, focused lasers and similar optical and photonic equipment used in the medical industry allow for more precise and accurate diagnosis and operation procedures.

While shaping light using conventional optics has been extremely valuable, the world has entered the nanotechnology era where devices are being made smaller and more compact. On reaching the fundamental limit of conventional optics, a new type of optics is needed to meet the demand for nano-optics and nanophotonic devices.

Conventionally, light is controlled by bulk optics. The electromagnetic field of light accumulates spatially-dependent phase shifts when propagating through bulk optics. As a result, the wavefront of light changes and the light beam travels in various ways depending on the shape of the optics. This requires the piece of optics to be much greater in size than the wavelength of the light used. Therefore, we need a new method other than phase propagation to shape light to create nano-sized devices.

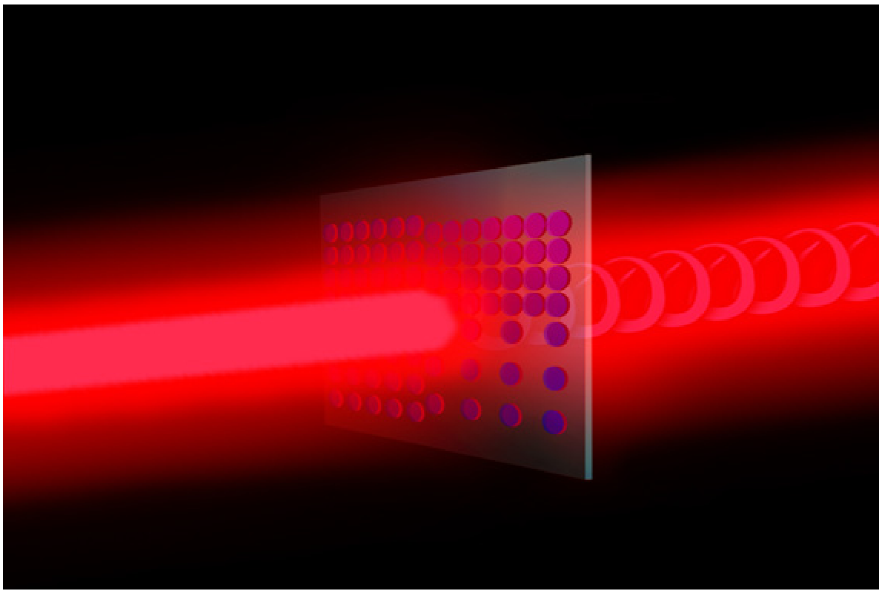
Such a new method can be provided using metasurfaces [1,2], namely thin layers of nano-size structures which exhibit optical effects not seen in nature, hence the name "Optics v.2". Due to various resonant effects, metasurfaces are able to imprint an arbitrary phase delay, from 0 to 2π, on an incident wavefront, hence removing the need for the phase accumulation mechanism used in bulk optics.

In particular, metasurfaces consisting of high-index dielectric resonant nanostructures have been shown to be a promising photonic platform for the implementation of highly-efficient and ultra-compact devices at optical frequencies [3]. This new class of materials not only eliminates the problem of material-related losses that are omnipresent in plasmonics, it also provides a multitude of different modes both of electric and magnetic nature [4,5] that can be selectively controlled and combined. Specifically, the strong electric and magnetic modes supported by silicon nanoparticles can be tailored for different applications by tuning the resonance positions and strength, and quality factor, which can be done through the altering of the nanoparticle size, shape and arrangement within the metasurface [5-7]. As a result, highly efficient metasurfaces capable of wavefront shaping and dispersion control can be realised.

Recently, several high-efficiency functional devices based on low-loss dielectric metasurfaces working in both reflection and transmission have been demonstrated, such as Gaussian-to-vortex beam-shapers [6,8] (illustrated in the conceptual image of this article) and holographic phase plates [7,9,10]. Silicon nano-pillars [9,10] and silicon nanodisks [6-8] are popular choices for these efficient devices because of their multiple geometric degrees of freedom. By manipulating the height, diameter and spacing between structures, which are needed for tailoring the resonance responses, reflection and transmission efficiency for the beam-shapers can potentially exceed 94% [8] and 95% [6] respectively. All of these exceed the performance of plasmonic metasurfaces by about one order of magnitude. Similarly, the holographic phase plates capable of complex wavefront control can also reach a potential efficiency of 82% [7] for the polarisation insensitive Huygens' metasurface and 91% [10] for the reflective nano-pillar hologram.

In particular, Huygens' metasurfaces have shown a unique advantage over other metasurfaces. Huygens' metasurfaces allow for full 2π phase control without the use of geometric phase due to the overlap of two electric and magnetic resonances [5], therefore polarisation independent or selective wavefront control can be achieved without sacrificing the transmittance level or phase range covered. Increasing interest in realising all-dielectric Huygens' metasurfaces have been seen very recently where several functional devices have been demonstrated [6,7,11,12].

Moreover, the spectral properties of silicon metasurfaces can be dynamically tuned and switched, for example within a liquid crystal cell, paving the way for actively tunable, adaptive metasurface



Optics v2.0: A Huygens' metasurface consisting of arrays of silicon nanodisks with various lattice periodicities can be used to turn a Gaussian beam into a vortex beam. Image credit: Geo Chong.

devices [13,14]. It is also important to note that due to the simple unit-cell geometry and the use of silicon, this new platform is highly compatible with large-area fabrication schemes and industrial silicon technology which is a crucial requirement for providing real-world photonic devices.

All in all, metasurfaces have provided a new way to control light in a much more compact manner with high efficiency, and as they are tailorable and easily manufactured devices, it is likely they will be seen in plenty of future photonic devices.

Acknowledgement
In 2015, I was awarded the Australian Optical Society Postgraduate Prize to attend two international conferences on Optics, namely SPIE Optics + Photonics in San Diego, and META'15 in New York City, where I presented my work on polarization independent beam shaper based all-dielectric Huygens' metasurfaces [6] mentioned in this article.

References

[1] N Yu and F Capasso, Nat. Mater. **13**, 139 (2014).
[2] A Minovich et al., Laser & Photon. Rev. **9**, 195 (2015).
[3] S Jahani and Z Jacob, Nat. Nanotech. **11**, 23 (2016).
[4] I Staude et al., ACS Nano **7**, 7824 (2013).
[5] M Decker et al., Adv. Optical Mater. **3**, 813 (2015).
[6] KE Chong et al., Nano Lett. **15**, 5369 (2015).
[7] KE Chong et al., ACS Photon. **3**, 937 (2016).
[8] Y Yang et al., Nano Lett. **14**, 1394 (2014).
[9] A Arbabi et al., Nat. Nanotech. **10**, 937 (2015).
[10] P Moitra et al., ACS Photonics **2**, 692 (2015).
[11] W Zhou et al., Sci. Rep. **6**, 30613 (2016).
[12] S Kruk et al., APL Photo. **1**, 030801 (2016)
[13] J Sautter et al., ACS Nano **9**, 4308 (2015).
[14] Y Huang et al., arXiv:1511.09380 (2015)

Katie Chong is with the Nonlinear Physics Centre, Australian National University.

News

Eureka Prizes 2016

Ewa Goldys from Macquarie University and the ARC Centre of Excellence for Nanoscale BioPhotonics and Martin Gosnell from Quantitative Pty Ltd have been awarded the ANSTO Eureka Prize for Innovative Use of Technology for their development of hyperspectral imaging technology, which enables the colour of cells and tissues to be used as a non-invasive medical diagnostic tool.
http://australianmuseum.net.au/2016-eureka-prizes-winners

Ewa Goldys and Martin Gosnell at the Eureka Prize award ceremony in Sydney. Photo courtesy of the Australian Museum.

IYL 2015 final report

The final report on the International Year of Light 2015 was presented in Paris at the UNESCO headquarters at the start of October. 13,168 events were held, reaching 147 countries and more than 100 million people, with many of the partnerships that were developed during IYL expected to continue now that the year long celebration has finished. The steering committee hope that even more can be achieved with greater communication and coordination between the scientific and political worlds. There were calls for a new annual celebration of photonics technology, a 'Day of Light' on the 16th of May, the anniversary of the first successful firing of a laser to continue and build on what was achieved during IYL.

'I believe that everyone involved in IYL 2015 can feel immensely proud of what has been achieved.' said John Dudley, Chair of the IYL 2015 Steering Committee. 'We can also feel confident that many of the partnerships established during IYL 2015 will continue. It is sometimes difficult to see how we as individuals can contribute to solving issues of global importance, but I believe that the International Year of Light has provided a timely reminder that through our commitment to education and outreach, we can really make a difference. It is now up to us to build on what we have learned and what we have accomplished during 2015 to continue to work together for the betterment of all.'

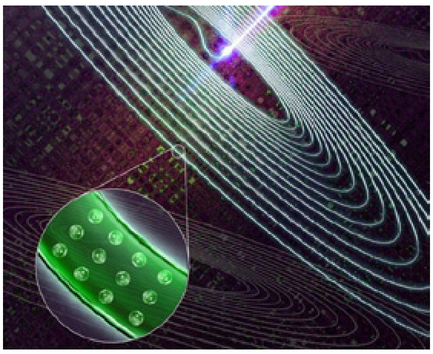
UNESCO
United Nations Educational, Scientific and Cultural Organization
International Year of Light 2015

Australian research in the news

Hybrid glass

A team from IPAS at the University of Adelaide led by Heike Ebendorff-Heidepriem has developed a way to integrate luminescent nanoparticles into glass, in collaboration with Macquarie University and University of Melbourne, published in Advanced Optical Materials. The hybrid glass has the optical properties of the nanocrystals and combines them with transparency and other properties of glass. They hope it can be used in sensing and biomedical imaging applications as well as in fibre-based devices.

Original article: DOI: 10.1002/adom.201600296



Graphic representation of nanoparticles embedded in glass. Credit: University of Adelaide.

OSA The Optical Society 100 Since 1916

ONE MEMBERSHIP

Infinite Possibilities

OSA Membership is an investment in your future—with professional benefits and vital connections that can last your entire career. That's why leaders in science, engineering and industry choose The Optical Society as their professional association.

As a member, you will gain access to an unparalleled, international network and the highest-caliber research. From the latest discoveries and news to members-only events and technical groups, The Optical Society is the organization of choice for leading professionals in optics and photonics, like you.

Get started. osa.org/join

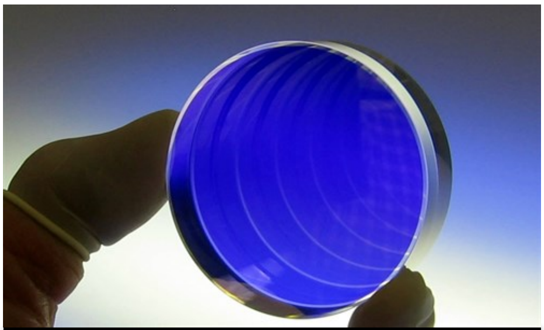
MICHAL LIPSON
Israel

ALVARO CASAS BEDOYA
Colombia

LIGHTMACHINERY IS A GLOBAL LEADER IN ULTRA HIGH PRECISION OPTICS

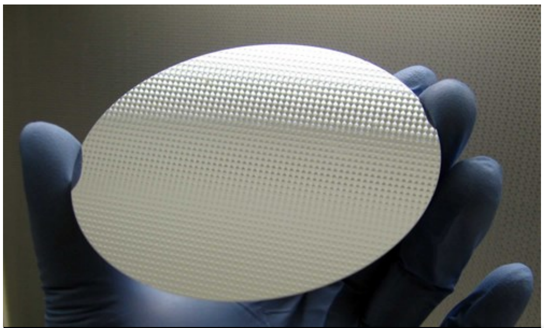
LightMachinery

Excellence in lasers and optics

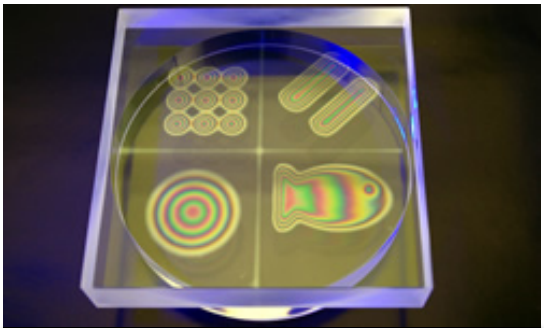


High performance etalons like this require thickness uniformity to better than lambda/150 rms. Coating thickness uniformity needs to be superb!

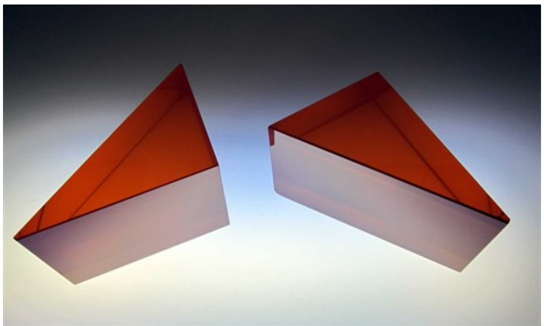
“Monolithic Achromatic Nulling Interference Coronagraph” (MANIC). An optic consistency of bonded prisms and a symmetric beamsplitter. The optic is designed to enable the direct detection of nearby Jupiter-like exoplanets – Boston University



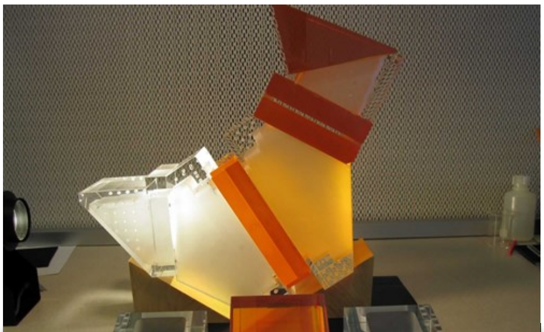
The ability to polish thin material very flat and uniform in thickness is a core expertise of LIghtMachinery.



Created with FJP technology, this demonstrates our ability to make completely arbitrary shapes to very high precision.



Zinc Selenide wedges for SWIFT, an IR doppler asymmetric spatial heterodyne Michelson interferometer for measuring upper atmospheric winds and ozone concentration. This is a very large, heavy instrument, the wedges are about 4” long.



This is the complete instrument prior to adding the last prism and the gratings.

Available from Raymax Lasers ™
e: info@raymax.com.au t: 02 9979 7646

Before Nobels: Gifts to and from Rich Patrons were Early Science's Currency

This article was originally published on
THE CONVERSATION

by Vera Keller

While the Nobel Prizes are 115 years old, rewards for scientific achievement have been around much longer. As early as the 17th century, at the very origins of modern experimental science, promoters of science realized the need for some system of recognition and reward that would provide incentive for advances in the field.

Before the prize, it was the gift that reigned in science. Precursors to modern scientists – the early astronomers, philosophers, physicians, alchemists and engineers – offered wonderful achievements, discoveries, inventions and works of literature or art as gifts to powerful patrons, often royalty. Authors prefaced their publications with extravagant letters of dedication; they might, or they might not, be rewarded with a gift in return. Many of these practitioners worked outside of academe; even those who enjoyed a modest academic salary lacked today's large institutional funders, beyond the Catholic Church. Gifts from patrons offered a crucial means of support, yet they came with many strings attached.

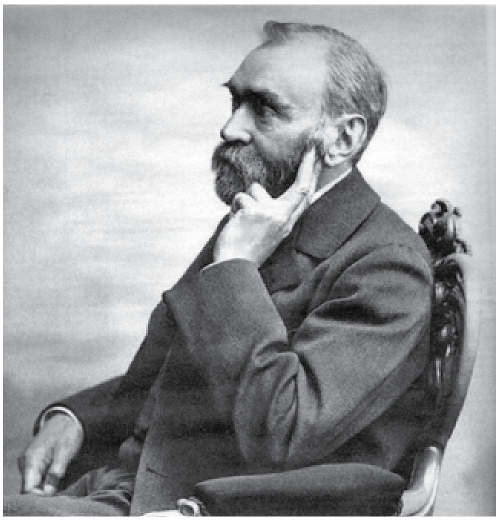
Eventually, different kinds of incentives, including prizes and awards, as well as new, salaried academic positions, became more common and the favour of particular wealthy patrons diminished in importance. But at the height of the Renaissance, scientific precursors relied on gifts from powerful princes to compensate and advertise their efforts.

Presented to please a patron

With courtiers all vying for a patron's attention, gifts had to be presented with drama and flair. Galileo Galilei (1564-1642) presented his newly discovered moons of Jupiter to the Medici dukes as a "gift" that was literally out of this world. In return, Prince Cosimo "ennobled" Galileo with the title and position of court philosopher and mathematician.

If a gift succeeded, the gift-giver might, like Galileo in this case, be fortunate enough to receive a gift in return. Gift-givers could not, however, predict what form it would take, and they might find themselves burdened with offers they couldn't refuse. Tycho Brahe (1546-1601), the great Danish Renaissance astronomer, received everything from cash to chemical secrets, exotic animals and islands in return for his discoveries.

Patrons often bestowed gold portrait medals with their own images, a form that survives in the Nobel medal to this day. The medal usually came on a chain that could be sold, but the recipient could not cash in on patron's image itself without offence.



Swedish inventor Alfred Nobel's profile is on the medals awarded to the recipients of the prizes he established. Portrait by Gösta Florman.

Galileo presents an experiment to a Medici patron. Painting by Giuseppe Bezzuoli.

Regifting was to be expected. Once a patron had received a work he or she was quick to use the new knowledge and technology in their own gift-giving power plays, to impress and overwhelm rivals. King James I of England planned to sail a shipful of delightful automata (essentially early robots) to India to "court" and "please" royalty there, and to offer the Mughal Emperor Jahangir the art of "cooling and refreshing" the air in his palace, a technique recently developed by James' court engineer Cornelis Drebbel (1572-1633). Drebbel had won his own position years earlier by showing up unannounced at court, falling to his knees, and presenting the king with a marvelous automaton.

Searching for better incentive structures

Gifts were unpredictable and sometimes undesired. They could go terribly wrong, especially across cultural divides. And they required the giver to inflate the dramatic aspects of their work, not unlike the modern critique that journals favour the most surprising or flashy research leaving negative results to moulder. With personal tastes and honour at stake, the gift could easily go awry.

A version of Drebbel's automaton sits on the table by the window in this scene of a collection. Painting by Hieronymous Francken II and Brueghel the Elder.

Scientific promoters already realised in the early 17th century that gift-giving was ill-suited to encouraging experimental science. Experimentation required many individuals to collect data in many places across long periods of time. Gifts emphasised competitive individualism at a time when scientific collaboration and the often humdrum work of empirical observation was paramount.

While some competitive rivalry could help inspire and advance science, too much could lead to the ostentation and secrecy that too often plagued courtly gift-giving. Most of all, scientific reformers feared an individual would not tackle a problem that couldn't be finished and presented to a patron in his or her lifetime – or even if they did, their incomplete discoveries might die with them.

For these reasons, promoters of experimental science saw the reform of rewards as integral to radical changes in the pace and scale of scientific discovery. For example, Sir Francis Bacon (1561-1626), lord chancellor of England and an influential booster of experimental science, emphasised the importance even of "approximations" or incomplete attempts at reaching a particular goal. Instead of dissipating their efforts attempting to appease patrons, many researchers, he hoped, could be stimulated to work toward the same ends via a well-publicised research wish list.

Bacon coined the term "desiderata," still used by researchers today to denote widespread research goals. Bacon also suggested many ingenious ways to advance discovery by stimulating the human hunger for fame; a row of statues celebrating famous inventors of the past, for example, could be paired with a row of empty plinths upon which researchers might imagine their own busts one day resting.

Bacon's techniques inspired one of his chief admirers, the reformer Samuel Hartlib (circa 1600-1662) to collect many schemes for reforming the system of recognition. One urged that rewards should go not only "to such as exactly hit the marke, but even to those that probably misse it," because their errors would stimulate others and make "active braines to beate about for New Inventions." Hartlib planned a centralised office systematising rewards for those who "expect Rewards for Services done to the King or State, and know not where to pitch and what to desire."

Moving toward a more modern mode

Collaborative scientific societies, beginning in the mid-17th century, distanced rewards from the whims and demands of individual patrons. The periodicals that many new scientific societies started publishing offered a new medium that allowed authors to tackle ambitious research problems that might not individually produce a complete publication pleasing to a dedicatee.

For example, artificial sources of luminescence were exciting chemical discoveries of the 17th century that made pleasing gifts. A lawyer who pursued alchemy in his spare time, Christian Adolph Balduin (1632-1682), presented the particular glowing chemicals he discovered in spectacular forms, such as an imperial orb that shone with the name "Leopold" for the Habsburg emperor.

Many were not satisfied, however, with Balduin's explanations of why these chemicals glowed. The journals of the period feature many attempts to experiment upon or question the causes of such luminescence. They provided an outlet for more workaday investigations into how these showy displays actually worked.

The societies themselves saw their journals as a means to entice discovery by offering credit. Today's Leopoldina, the German national scientific society, founded its journal in 1670. According to its official bylaws, those who might not otherwise publish their findings could see them "exhibited to the world in the journal to their credit and with the praiseworthy mention of their name," an important step on the way to standardising scientific citation and norms of establishing priority.

Beyond the satisfaction of seeing one's name in print, academies also began

Francis Bacon saw the need for better incentive systems in science. Portrait by Simon Passe.

Louis XIV surveys the members of the Royal Academy of Sciences in 1667. Painting by Henri Testelin.

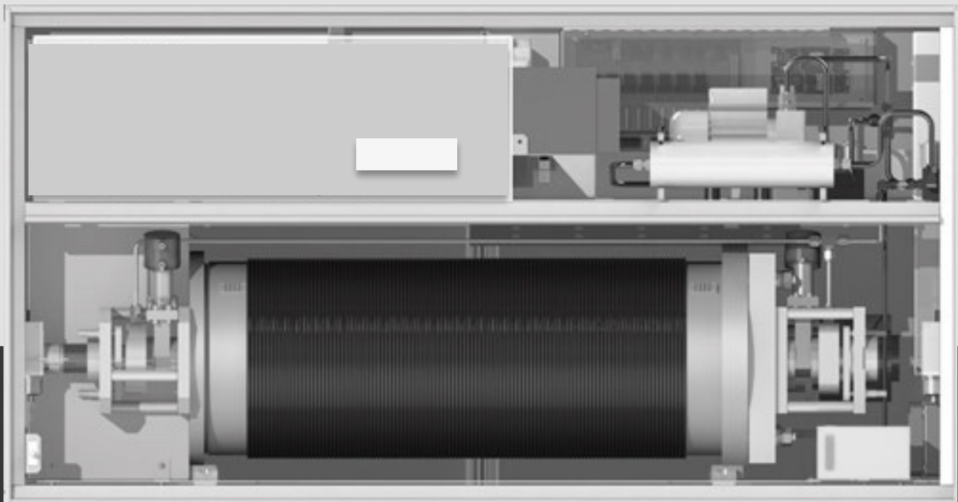
offering essay prizes upon particular topics, a practice which continues to this day. Historian Jeremy Caradonna estimates 15,000 participants in such competitions in France between 1670, when the Royal Academy of Sciences began awarding prizes, and 1794. These were often funded by many of the same individuals, such as royalty and nobility, who in former times would have functioned as direct patrons, but now did so through the intermediary of the society.

States might also offer rewards for solutions to desired problems, most famously in the case of the prizes offered by the English Board of Longitude beginning in 1714 for figuring out how to determine longitude at sea. Some in the 17th century likened this long-sought discovery to the philosophers' stone. The idea of using a prize to focus attention on a particular problem is alive and well today. In fact, some contemporary scientific prizes, such as the Simons Foundation's "Cracking the Glass Problem," set forth specific questions to resolve that were already frequent topics of research in the 17th century.

The shift from gift-giving to prize-giving transformed the rules of engagement in scientific discovery. Of course, the need for monetary support hasn't gone away. The scramble for funding can still be a sizable part of what it takes to get science done today. Succeeding in grant competitions might seem mystifyng and winning a career-changing Nobel might feel like a bolt out of the blue. But researchers can take comfort that they no longer have to present their innovations on bended knee as wondrous gifts to satisfy the whims of individual patrons.

Vera Keller is Associate Professor of History, University of Oregon.

The original article can be found at theconversation.com/before-nobels-gifts-to-and-from-rich-patrons-were-early-sciences-currency-66360



Conferences

27 November - 2 December 2016   IONS KOALA 2016

The 9th Conference on Optics, Atoms and Laser Applications (KOALA) and International OSA Network of Students (IONS) event will be co-hosted by students from Monash and Swinburne Universities in Melbourne from Sunday 27th November to Friday 2nd December 2016. IONS KOALA is Australia and New Zealand's only student conference in the fields of optics, quantum optics, atom optics, photonics and laser technology.   ionskoala.osahost.org, or email info@koala2016.com

4-8 December 2016   AIP Congress and Asia Pacific Physics Conference

APPC-AIP

The 13th Asia-Pacific Physics Conference in conjunction with the 22nd Australian Institute of Physics Congress will be held in the Brisbane Convention Centre from Sunday 4 to Thursday 8 December 2016. This joint meeting will enhance links in the Asia-Pacific region and will incorporate the AOS Annual Meeting.   appc-aip2016.org.au

12-14 December 2016   COMMAD 2016

The 13th International Conference on Optoelectronics and Microelectronic Materials and Devices will be held in Sydney from Monday 12 to Wednesday 14 December 2016. COMMAD is held biannually and provides a forum for Australian and international semiconductor communities to meet and discuss topics related to microelectronic and optoelectronic materials, processes and devices including nanoscale and quantum technologies. COMMAD 2016 will bring together over 200 scientists, engineers, students and industrial collaborators to discuss new and exciting advances in these fields.   commad2016.org.au

24-28 April 2017 International Conference on Optical Fiber Sensors

The 25th International Conference on Optical Fiber Sensors (OFS) will be held in scenic and beautiful Jeju Island, Korea from 24 to 28 April 2017. OFS was established in 1983, and is acknowledged as the world's leading conference on all topics related to photonic sensing technologies. The conference provides a forum for reporting and exchanging ideas on the latest advances in research and development on fiber-optic and photonic sensing. It has also contributed significantly to industrialization and standardization of the related devices and systems for field deployment. OFS will offer plenary and invited talks, contributed oral and poster presentations, workshops, and exhibition of commercial products. Social and cultural events will also take place to foster networking among the participants in a friendly setting.

Diffractive Imaging for Quantitative Stress Analysis

Diffractive imaging is a highly diverse field that exploits diffraction data from the interaction of a coherent beam with a scattering sample to gain information regarding the sample's absorption and phase shift. Here we describe recent work at La Trobe University as part of the ARC Centre of Excellence for Advanced Molecular Imaging to develop an optical diffractive microscope capable of quantifying stress within biological and materials science samples.

by Nicholas Anthony, Guido Cadenazzi, Keith Nugent and Brian Abbey

Diffractive Imaging

Resolution limitations and sample requirements have led to a steady evolution in new microscopy techniques to better characterise our world at smaller and smaller scales. From advancements in Synchrotron-based and electron beam microscopies to the development of X-Ray Free Electron Lasers (XFELs), the ways in which we can understand our world at the smallest scales is having profound and long lasting effects. Optical based microscopies are not immune to these advancements. New ways of using light has led to new techniques, such as confocal microscopy, and new optical elements that have led microscopes to the fundamental limits of imaging.

However, optical techniques which depend on lenses are sensitive to aberrations and lens manufacturing errors. High resolution images rely on expensive and complex optical elements that need to be manufactured to precise criteria. To overcome such limitations, Coherent Diffractive Imaging (CDI) [1], a lensless technique that uses diffraction data and image reconstruction algorihms in place of image forming optics to measure objects has been used.

By removing the need for optical elements between the sample and detector the resolution becomes limited only by the quality of the diffraction data collected and the dose given to the sample. The added benefit of diffractive imaging is its ability to provide both the amplitude and phase of a sample. This is especially useful when dealing with biological samples which are often weakly absorbing and hence traditional microscopes which rely on intensity images can only achieve low contrast. However, the phase shift of the incident light as it passes through these samples is significant enough that if it can be obtained a higher contrast image of thin and lowly interacting objects is possible.

In comparison to x-ray techniques in the visible regime there are a wide variety of high quality optical lenses readily available for imaging, meaning the use of CDI has not been widespread. However, optical diffractive imaging of biological samples is starting to become a hot area of research, overcoming limitations in x-ray and electron techniques, namely that high energy x-rays and electrons are highly damaging to biology or require non favourable sample preparation methods.

Below is an account of an optical diffraction microscope designed and developed at La Trobe University, Melbourne. This microscope is not only shown to be capable of imaging samples to high quality but also capable of using the extra phase information available to quantify stresses and strains within objects.

Microscope Design

The concept of CDI is simple; a probe of coherent illumination is directed towards a sample which imprints amplitude and phase information upon it. The beam continues to propagate and the resulting diffraction information collected using a detector. Although a simple interaction, in practice obtaining high quality, useful, data can be difficult and there are many variations on the simple CDI format to utilise its inherent strengths and weaknesses [2].

The optical system here was designed to be a high resolution, high speed and high throughput system made using readily available components. To achieve this the microscope was designed to be as simple as possible and to be easily customisable, allowing for sample variations and ease of data collection.

In our microscope a 633 nm red laser is passed through a polariser and quarter wave plate producing circularly polarised light. This beam is expanded using a 20x beam expander producing a beam of approximately 50 mm in diameter. This beam is allowed to propagate before being cropped to a chosen size to produce a well-defined beam. The beam is then focused by a condensing lens or microscope objective. The light interacts with a sample, placed at or close to the focus on a six-axis hexapod, and the resulting beam is analysed using a second quarter wave plate and polariser before being collected on an sCMOS detector. The free-space propagation allows for no reduction in data quality from optical elements. The use of an aperture and lenses allows for the beam to be well characterised at all points.

The set-up is easily modified with the analysing optics mounted with motorised rotation controllers that are easily removed for imaging of samples to higher spatial resolution, or when polarised light is not

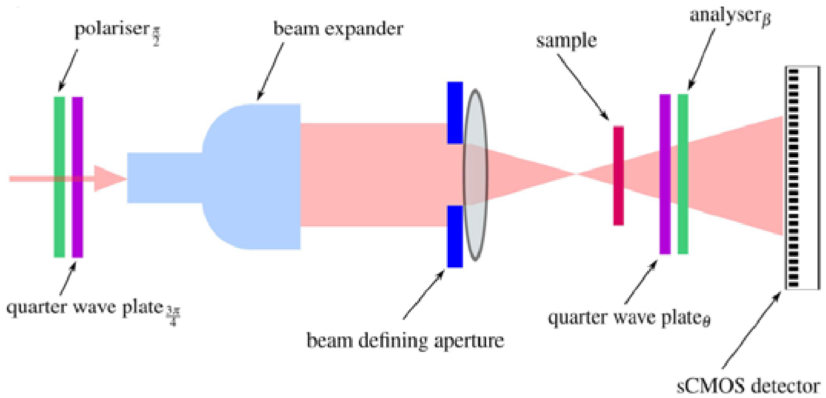


Figure 1. Schematic of the produced microscope showing the path of the beam as it traverses through optics before interacting with the sample and the data collection using an sCMOS detector.

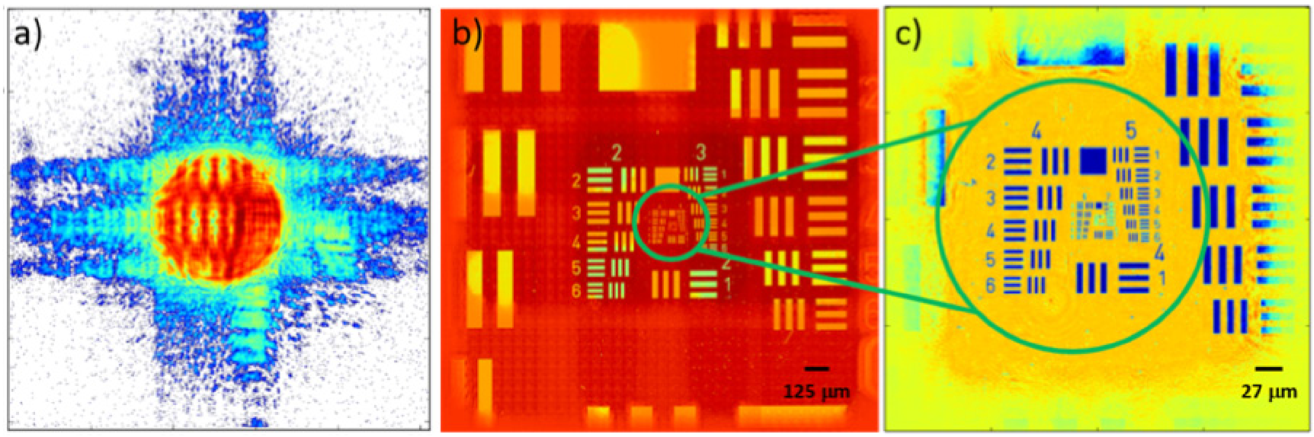


Figure 2. USAF 1951 Test Target a) diffraction data collected, b) reconstructed amplitude of large field of view with a grid scan, c) smaller field of view, higher resolution Fermat scan.

necessary. A series of different objective lenses and beam defining apertures paired with the ability to place the sample and detector at different locations, allow high resolution and large area scans to be performed.

Data Collection & Reconstruction

Ptychography is an extension of CDI that uses a series of overlapping beam interaction positions to introduce extra redundancy into the measurement [3],[4]. Ptychography measurements are traditionally performed in a grid pattern, however for increased speed and reconstruction quality our microscope uses a Fermat Spiral pattern with an optimised distance between points [5]. By using a spiral compared to a grid the reconstructed images are of higher quality with fewer artefacts in the final image. Moreover, the total scan time is reduced by optimising the motor movements. The use of a Fermat Spiral also allows for a larger degree of overlap to be used using the same number of scan points and covering the same area.

Once the data is collected and processed, image reconstructions are performed using the extended Ptychographical Iterative Engine (ePIE) reconstruction algorithm [6]. The algorithm uses Fourier Transforms to iteratively obtain a solution of the sample by propagating the collected image from the detector plane to the sample plane and back again and applying constraints as it goes. This iterative process and the information redundancy of ptychography also allows the probe used to be obtained in the reconstruction process.

Results

The field of view and resolution of the microscope can vary greatly depending on the scans performed. Figure 2 shows an example set of data from a USAF 1951 Resolution target. The collected diffraction data from each position (figure 2a) is processed by applying a threshold and background subtraction. The processed data is then read into a reconstruction algorithm (in this case ePIE) and allowed to iterate until the error margin is sufficiently low. Figure 2b shows the reconstructed amplitude of a large field of view scan taken with a series of overlapping grid scans; artefacts are visible across the image as a series of dots, and these are from the periodic grid scan. In comparison, figure 2c was taken using a Fermat spiral; note the amplitude image is a lot smoother and has few artefacts. This image is also taken at a higher resolution.

The USAF test target is a good sample to show microscope capabilities, however it is not a good sample to show the added benefit of the phase. Biological structures on the other hand are a good sample as they are known to show low contrast in traditional microscopies. In Figure 3 the amplitude (figure 3a) and phase (figure 3b) are shown of a sectioned rat lung. There is little contrast variation in the amplitude, however the phase reveals much more detailed information.

Quantitative Stress Imaging

Determining stress is crucial for predicting mechanical behaviour, be it in biological or material sciences. However, the measurement of the varying stress tensor across a sample is not an easy task. Many methods exist for characterising stress, with the most common approaches relying on accurate models to simulate the stresses within well-defined objects [7]. The drive for more accurate and sensitive techniques to measure stress in optically transparent materials, such as thin films, mean that stress measurement using polarised light based on the principle of photoelasticity, is undergoing a renaissance.

Photoelastic imaging is a full-field approach that uses polarised light to obtain a map of the refractive index differences at all points across the sample. Although useful for viewing stresses, photoelastic imaging is a qualitative technique, so for quantitative information to be obtained it needs to be paired with other theoretical and experimental techniques. It is this concept which has motivated our current work in developing

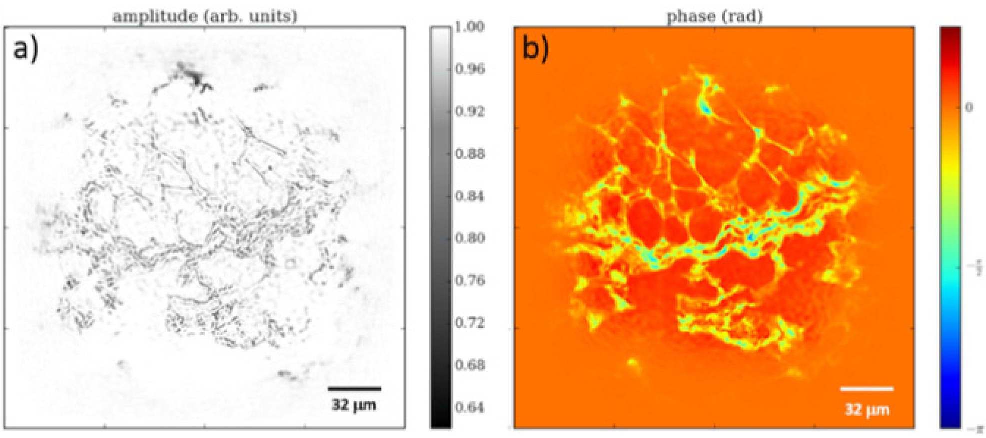


Figure 3. Reconstructed a) amplitude and b) phase of a rat lung.

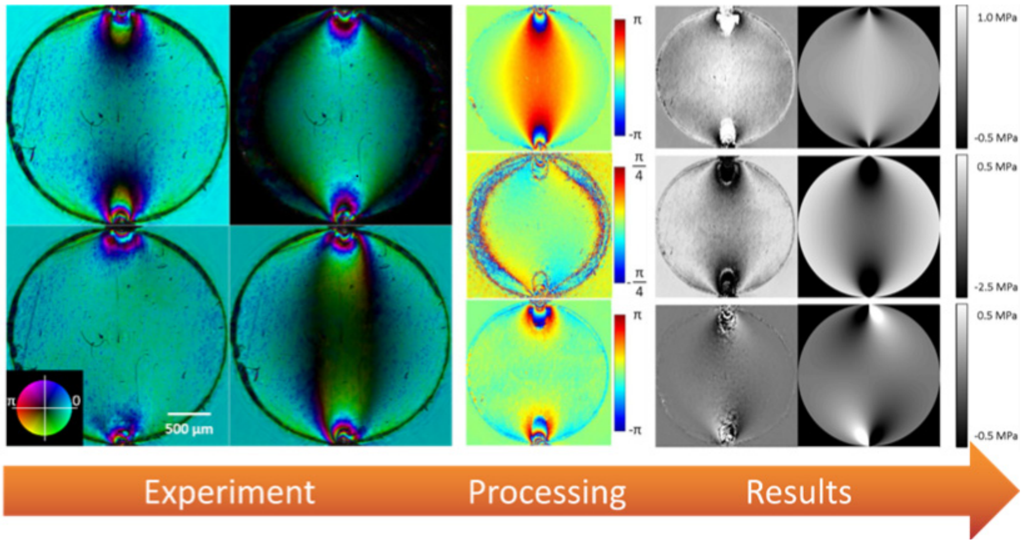


Figure 4. Quantitative Stress imaging. a) Four of the five configurations imaged. Brightness is amplitude, hue is phase. b) Wrapped phase maps of the isochromatics, isoclinics, and isopachics. c) Resulting stresses in the x, y, and xy directions, where the experimental results are compared to theory [8].

photoelastic ptychography.

The information that we require to be able to quantitatively determine stresses are the perpendicular phase retardations δ_1 and δ_2, and the angle, α, that they make with the instrument reference frame. Photoelasticity can qualitatively provide this information using fairly rudimentary experimental setups. When a strongly birefringent sample is viewed using a set of polarisers held at extinction, dark and light intensity fringes are observed. These fringes represent 2π phase shifts of the light as it's selectively retarded by the stresses within the object. Traditionally there are two types of fringes that can be seen. The first type are isoclinic fringes, which are lines of constant α, visible using linearly polarised light. The second type are called isochromatic fringes, which give the principal stress difference observed using linear or circularly polarised light. As only the angle and the principal stress difference can be obtained, normally there is not enough information available for quantitative stress determination.

With knowledge of the phase a third type of fringe can be obtained, known as the isopachic, or principal stress sum. As ptychography is able to obtain both a sample's amplitude (and hence intensity) and phase, we can calculate all three types of fringes to quantitatively determine stress. Our microscope uses three stages to do this; data collection, data processing, and stress separation.

To collect the relevant data the object is imaged at five different configurations of circularly polarised light and the amplitude and phase reconstructed. The first four configurations are used to provide continuous information across the sample, including in positions of zero intensity, such as in the dark fringes. The fifth configuration is used specifically to determine the isopachic parameter.

This information is then processed to develop continuous phase maps of the isochromatics, isoclinics, and isopachics. Taking multiple measurements ensures that any ambiguities can be accounted for. These phase maps are corrected using phase unwrapping algorithms after which the information from the three sets of data can be combined to obtain the independent principal stress components and angles.

Some simple algebra is used to convert the principal stresses in the sample coordinates into the lab reference frame in order to provide shear and plane stress information which can also be mapped.

The results shown in figure 4 are from a proof-of-principle experiment undertaken on a diametrically compressed plastic disc. This sample was used as it is a well-understood system with a well-known analytical solution as can be seen in figure 4c where the experimentally obtained stresses are compared with the theoretical solution.

This work is currently being applied to more complicated, 'real-world' samples including biological cells. More information about this experiment can be found in the article published in Scientific Reports [8].

Conclusions

Here we have discussed recent work at La Trobe University to develop an optical photoelastic, ptychographic microscope capable of high resolution and large field of view imaging. The method of ptychography has been briefly outlined along with the potential benefits it offers in terms of quantitative phase imaging. The use of this microscope as a means to quantitatively image stress has been presented with a full report being published in Scientific Reports (2016).

References

[1] KA Nugent, *Coherent methods in the X-ray sciences*, Advances in Physics **59**, 1-99 (2010).

[2] P Thibault and IC Rankenburg, *Optical diffraction microscopy in a teaching laboratory*, Am J Phys, **75** (9), 827 (2007).

[3] AM Maiden, JM Rodenburg, and MJ Humphry, *Optical ptychography: a practical implementation with useful resolution*, Opt Lett, **35** (15), 2585-7 (2010).

[4] JM Rodenburg, *Ptychography and Related Diffractive Imaging Methods*, Imaging and Electron Physics, **150** (7), 87-184 (2008).

[5] X Huang, H Yan, R Harder, Y Hwu, IK Robinson, and YS Chu, *Optimization of overlap uniformness for ptychography*, Opt Express **22** (10), 12634-12644 (2014).

[6] AM Maiden and JM Rodenburg, *An improved ptychographical phase retrieval algorithm for diffractive imaging*, Ultramicroscopy, **109** (10), 1256-62 (2009).

[7] H Wieringa (ed.), *Experimental Stress Analysis*, Martinus Nijhoff Publishers, (1986).

[8] N Anthony, G Cadenazzi, H Kirkwood, E Huwald, K Nugent, and B Abbey, *A Direct Approach to In-Plane Stress Separation using Photoelastic Ptychography*, Sci Rep **6**, April, 30541 (2016).

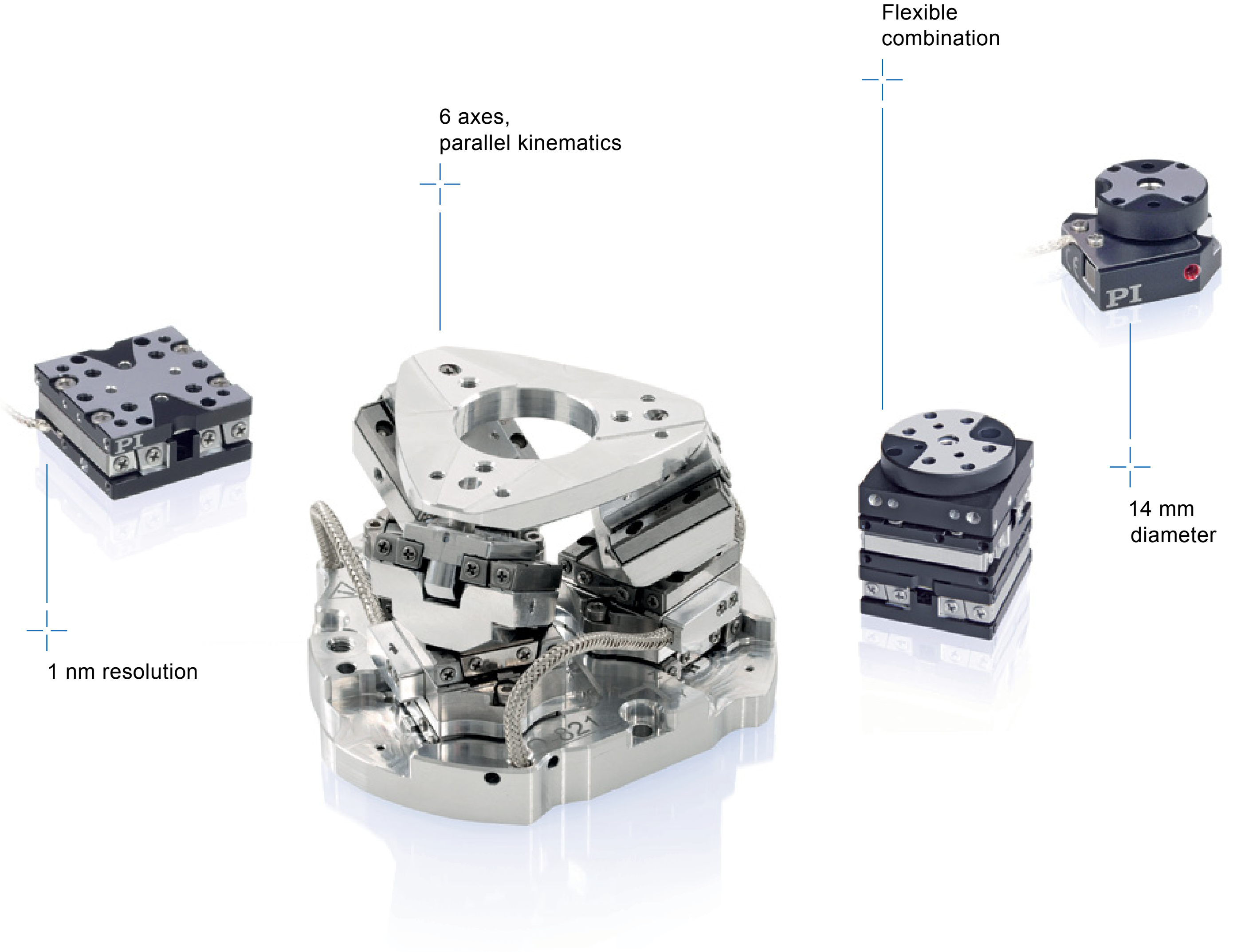
Nicholas Anthony, Guido Cadenazzi, Keith Nugent and Brian Abbey are with the ARC Centre of Excellence for Advanced Molecular Imaging, La Trobe University.

Warsash Scientific
Advanced Instruments for Research & Industry

PI

The new HEART OF MOTION

Q-MOTION. PRECISE, SMALL, AFFORDABLE.



PI – The Broadest and Deepest Portfolio, the Best Solution.

sales@warsash.com.au tel: +61 2 9319 0122 www.warsash.com.au

Optics in Everyday Life: Confessions of a Deuteranope

by Tony Klein

Colour blindness, or colour vision deficiency (CVD), although not all that uncommon, is not very well understood by people with normal vision.

About 8% of men - but only about 0.6% of women - in our society exhibit this form of genetic defect and are said to be colour blind which, by the way, is called "*Daltonism*" in French, named after John Dalton the noted chemist, who was one of its more notorious sufferers and generators of anecdotes.

The most common form of colour blindness, called red-green colour blindness, is caused by a defect on the X chromosome, of which males have only one copy, whereas females, who have two copies may be protected by the other X chromosome if it has a non-defective gene. However, one half of their male offspring will be afflicted and thus they are "carriers". In my case, I inherited my colour blindness from my maternal grandfather, and my grandson got it from me, via my daughter, who has perfect colour vision. Half my daughters and my grand-daughters are likely to be carriers.

So, what is this defect? As is well known, there are two types of light receptor cells in the human retina: rods and cones. It is the cones that are responsible for colour vision - the more abundant rods are extremely sensitive to light, but only give black-and-white information for night-vision (and information on motion and edge detection in brighter light). (By the way, recent experiments have shown that one single photon is capable of triggering the receptors, provided that they have escaped capture by intervening tissue).

There are three types of cones, responsive to short, medium and long (i.e. S, M and L) wavelengths of visible light, but actually they have three different spectral sensitivities, as shown in figure 1.

In a somewhat simplified explanation, if one of the M, L or S cone types is missing (or has a shifted spectral sensitivity) in a person's retina, they will be 'colour blind'. Those missing a cone type are so-called "dichromats": "green-blind" or "deuteranope" (like I am) if missing the M cones, "red-blind", or "protanope" if missing L cones (like my late friend and colleague, Geoff Opat was), "blue-blind", or "tritanope" in the rare case of missing the S cones.

What does this mean in practice? In the case of Geoff Opat, he could not see red traffic lights or only very dimly, and couldn't see red flowers very well. In my case, I see grass etc. as some shade of brown - but it's really more complicated than that. Our world is still full of colour - around 10,000 different hues, in fact, whereas people with normal colour vision can see about 1,000,000. I do, however, have trouble with red flowers having a very low contrast with the surrounding green leaves in certain beautiful trees like the "flame tee" or Poinciana. Often I can't see them until up close. But I have no trouble at all with traffic lights: The "green" is really very bluish.

It's a bit like a colour printer with one of the cartridges missing, but not really: The Cyan, Yellow, Magenta system of colour printing is quite different from the Short, Medium, Long wavelength cones in the retina, but each system has in common a triple manifold of colours, i.e. needing three numbers to specify a hue. I found a better set of examples in Wikipedia, while researching this column. Under "Colour Blindness" (which tells you more about

Figure 2. The same scene as seen by those with a) normal vision b) deuteranopic vision c) tritanopic vision. Image credit: Q-Lieb-In. Simulations performed via www.vischek.com.

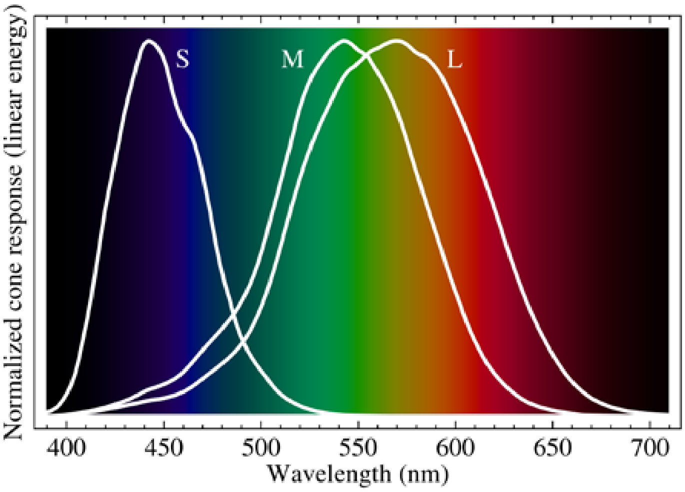


Figure 1. Spectral Sensitivities of the three types of cone cells.

the subject than you might wish to know) there are pairs of pictures that show what a normal and a red-green blind person would see. In spite of the limitations of the computer screen or of the printed page, they look pretty good to me: I can't tell the difference! If you, the reader can't either, then you may be part of the 8% (if male) or the 0.6% (if female) - join the "club". The pictures are shown in figure 2.

A very interesting issue concerns colour vision in animals: There are a range of different colour vision systems in animals; birds, fish, reptiles and amphibians can have four cone types, and insects and other animals see into the ultra-violet. However most mammals are dichromats, with only two cone types - so people like me are by no means alone, with some primates and marsupials as the only mammals (alongside humans) with trichromatic vision. Furthermore some more recent research shows that the third type of cone has evolved more recently in (old-world) monkeys and presumably humans and other fruit-eaters in order to distinguish ripe fruit. This is illustrated in figure 3: red and green apples as they appear to normals and deuteranopes. Once again, I can't tell the difference!

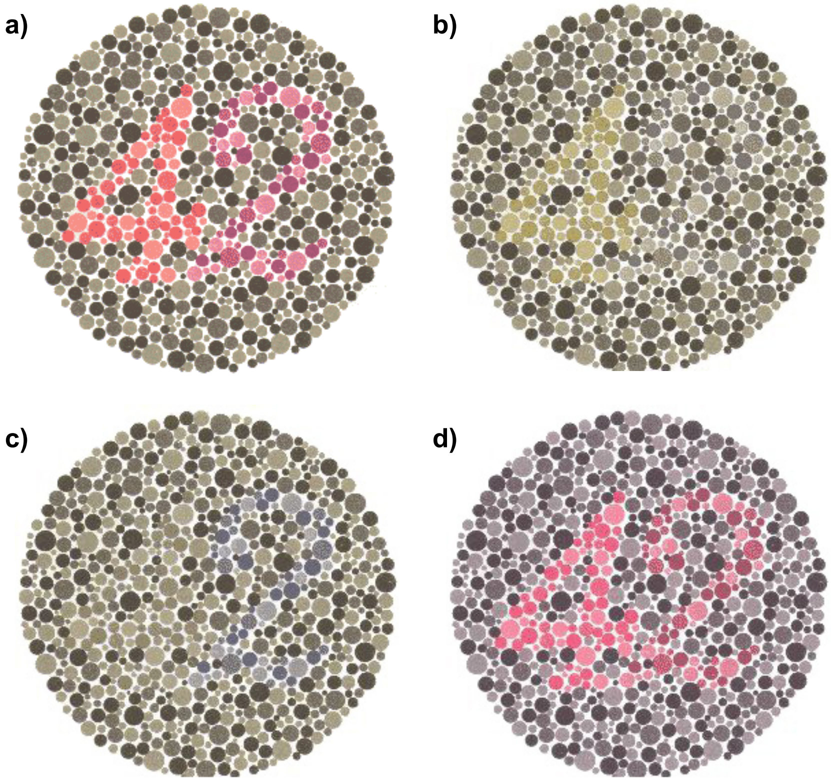


Figure 4. Example of an Ishihara test plate and simulations of how it might appear to those with CVD. a) People with normal colour vision see the number 42. b) I, a Deuteranope, see the number 4 (a faint 2 may also be seen). c) Protanopes see the number 2 (a faint 4 may be seen). d) Tritanopes see the number 42. Simulations performed via www.vischek.com.

So what sort of handicap is colour blindness and how is it diagnosed? In my case, at around the age of 3, it was found by my mother that I was using "crazy" colours in colouring books, e.g. ships sailing on violet seas instead of blue. She knew that her father had trouble with colours but they all thought that he had trouble *naming* colours because they didn't understand the concept of CVD. But to me it represented hardly any handicap in perceiving the wonderfully coloured world.

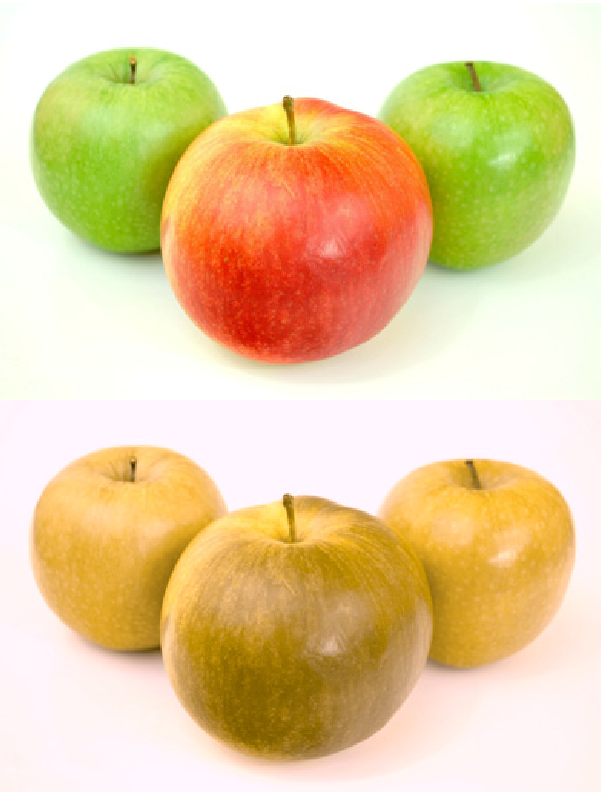


Figure 3. A mix of red and green apples as they might appear for those with normal vision (top) and deuteranopes (bottom). Simulations performed via www.rehue.net.

Much later, however, as a teenager, I was chucked out of flying school (much to the relief of my parents) when my CVD was properly diagnosed. This was done by the use of the most common test, the one named after its promulgator, Professor Ishihara (several other tests exist for other, more subtle types of CVD). The Ishihara test consists of subtly coloured dots showing numbers hidden among other coloured dots. The perceived numbers are different for normal and colour blind subjects. An example of one such test pattern is shown in figure 4.

Apart from being prohibited from certain occupations such as piloting or train-driving, I have hardly felt any handicap apart from a few incidents with colour-coded wires and electronic components. But otherwise it was more of a source of amusement, such as when a cousin and I (who shared a common maternal grandfather) marvelled at a rare, orange-bellied parrot, which turned out to have been bright green. But we had no trouble at all with rainbow lorikeets - and rosellas which are, to us, bright brown and red.

Acknowledgement
I am very grateful to Dr Jessica Kvansakul, whose PhD was in the area of vision science, and whose normal colour vision allowed her to make significant improvements to the text and to the illustrations.

Emeritus Professor Tony Klein is a Foundation Member and Past President of the AOS. Tony is with the School of Physics, University of Melbourne.

Product News

BeAM and GeonX

BeAM, the European leader in additive manufacturing machines based on laser metal deposition technology, and GeonX, a software provider specialising in next-generation virtual manufacturing solutions for science and industry, are forming a strategic alliance with a view to developing the world's first integrated Simulation-Process-Machine system.

Under the partnership, GeonX's virtual factory solution Virfac® is to be integrated into BeAM's design tools to enable enhanced, faster production. The integrated new system will further extend the partners' technological edge. BeAM will therefore be able to speed up the process development stage, while ensuring optimal quality by simulating the manufacturing stage upstream. Ultimately, this will boost competitiveness for the end client.

OPTEC

Belgium based Optec s.a. is a leading global supplier of micromachining systems used in research and industry that can be built to suit specific requirements. A recent system built for Karlsruhe Institute of Technology was a multi-wavelength and high repetition femto/picosecond workstation. To deploy and index the system's three galvo heads with near-perfect sub-micron repeatability, Optec developed a novel Turret Optics (TO) design using a combination of Aerotech and PRO series linear vertical stages.

When compared to Inline Optical (ILO) designs, the TO system provides superior positioning performance, is more compact and with fewer positioning axes, requires less complex control, has faster development and build timescales and lower component costs.

For more information please contact Raymax at info@raymax.com.au or 02 9979 7646

Superfast camera for nanosecond time-resolved imaging

Andor has released its new iStar intensified sCMOS camera with a unique combination of nanosecond gating, high sensitivity, high dynamic range and superfast frame rate.

The new camera offers frame rates at least 50% faster than competing CCD or interline while offering intrinsically low noise floor. A better signal-to-noise ratio can be achieved with lower intensifier gain, yielding higher dynamic range.

The iStar series offers < 2 ns optical gating on a range of high QE Gen 2 and Gen 3 intensifiers, with gating repetition rates up to 500 kHz. The fully integrated, triple output delay generator features an ultra-low insertion delay and excellent timing accuracy down to a few 10's of picoseconds, allowing for extremely precise synchronisation of complex experiments through a comprehensive range of input/output triggering options.

The acquisition speed, sensitivity and gating capabilities of the iStar sCMOS make it a highly attractive choice for fast plasma imaging, combustion studies based on Planar Laser-Induced Fluorescence (PLIF), transient absorption and time-resolved luminescence.

For further information please contact Coherent Scientific at sales@coherent.com.au or 08 8150 5200

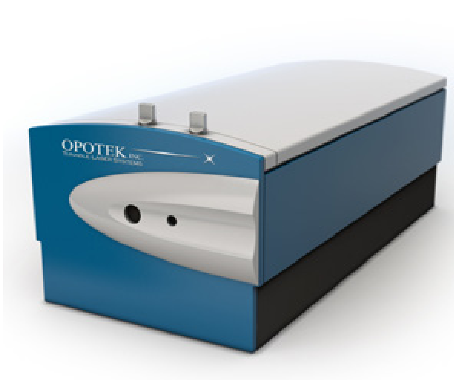
Fibre Laser with 3kW Output

Coherent's HighLight FL series of fibre lasers is now available with power up to 3kW, suitable for cutting and welding a wide range of metals and alloys.

The new lasers use Coherent's unique modular architecture, which allows customers to choose either complete lasers with turn-key operation or modules to build their own custom laser systems.

The lasers can be modulated up to 5kHz with an external trigger signal for pulsed mode operation. An external analog signal can be used to set the output power and to ramp the laser power in a controlled manner to avoid artefacts at the corner of a cut or the beginning/end of a weld.

New OPO Provides Tunable Pulses from Deep-UV to Near-IR



Opotek's new Radiant OPO is a tunable laser system which generates nanosecond pulses tunable from the deep-UV to the NIR. Available in a 355nm or 532nm pumped configuration, the Radiant integrates all components into a single compact unit with a rugged design to minimise misalignment and allow easy relocation of the laser without the need for realignment. Wavelength tuning is PC-controlled and requires no user adjustments.

Every harmonic and OPO module inside the Radiant is hermetically sealed to protect the sensitive optical components, increasing the laser lifetime and reducing cost of ownership. All tunable beams exit the laser from the same port, resulting in a single beam path to the experiment.

Key features of the Radiant are:

- >60mJ output (high energy version)
- 192-2500nm tuning range
- Low divergence design, <2mrad
- Hands-free, PC controlled tuning
- 100 million shot flashlamp lifetime
- Fully integrated Quantel Q-smart pump laser

For further information please contact Coherent Scientific at sales@coherent.com.au or 08 8150 5200

NIR and timing resolution optimised SPCM

Warsash Scientific is pleased to announce the release of the all new high performance NIR and TR enhanced single photon counting modules (SPCM) from Excelitas Technologies. Excelitas Technologies is a global leader focused on delivering innovative, customised optoelectronics solutions.

Excelitas Technologies have extended its portfolio of low-light-level detection modules with enhanced versions of the well-known SPCM single photon counting module that is based on a unique silicon avalanche photodiode with a circular active area, achieving extremely high photon detection efficiency over a 180 μm diameter with unmatched uniformity over the photodiode. In addition to the standard AQRH series of modules offering 6 output signal options, the SPCM-AQ4C 4-channel photon counting array module, there are now more choices for various single photon counting applications.

The new SPCM-AQRH-TR is a fast timing enhanced version with timing resolution of less than 250 ps, designed to support applications such as time correlated single photon counting (TCSPC), fluorescence lifetime measurements and fluorescence lifetime imaging microscopy (FLIM).

The new SPCM-NIR is a high Photon Detection Efficiency enhanced version with optimised sensitivity in near infrared wavelengths, designed to support long range LIDAR, quantum communication, photon entanglement, and other photon counting applications in the NIR (700-1060 nm).

For more information, contact Warsash Scientific at sales@warsash.com.au or +61 2 9319 0122

Compact green-yellow lasers up to 200 mW with direct modulation up to 50 kHz

Cobolt AB, Swedish manufacturer of high performance lasers, introduces modulation capability on the diode pumped lasers (DPL) in the green-yellow region of the Cobolt 06-01 Series of plug and play CW lasers. The 06-DPLs are available at 532 nm and 561 nm with up to 200 mW output power and offer direct intensity modulation (analog and digital) at up to 50 kHz.

The 06-DPL lasers complement the modulated diode lasers (MLDs) already available in the Cobolt 06-01 Series, which offer a market leading combination of modulation extinction ratios (>10 000 000:1) and high speed (up to 150MHz). Together, the 06-MLD and 06-DPL lasers in the Cobolt 06-01 Series offer a very complete spectrum of directly modulatable wavelengths from 405 nm to 660 nm in a compact form factor, ideal for demanding life science applications.

All Cobolt lasers are manufactured using proprietary HTCure™ technology and the resulting compact hermetically sealed package provides a very high level of immunity to varying environmental conditions along with exceptional reliability. Lasers built using the HTCure™ technology have been shown to withstand multiple 60G mechanical shocks in operation without any sign of degraded performance. With thousands of installed units in the field, HTCure™ has proven to be one of the most reliable methods for making industrial grade lasers.

For more information, contact Warsash Scientific at sales@warsash.com.au or +61 2 9319 0122

Cooled high-energy CCD for direct X-ray detection from Raptor Photonics

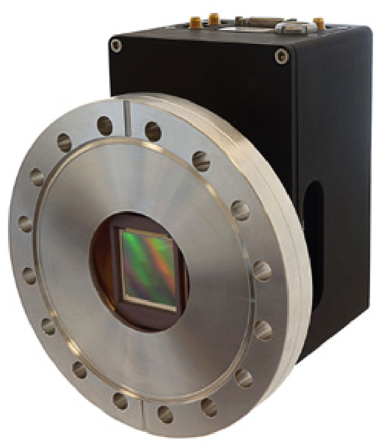
The newest addition to the Eagle family, the Eagle XO, uses a cooled 1 or 4MP CCD for direct detection of soft X-ray up to 20 keV. The open front end interfaces directly to vacuum chambers, making it ideal for synchrotrons and for plasma physics research. The deep cooled, back-illuminated CCD allows for ultimate sensitivity and noise performance.

Key features:

- CF152 (6") flange for direct interfacing to vacuum chambers
- 2048 × 2048 back-illuminated CCD
- 1.2 eV to 20 keV direct detection
- Extremely low dark current < 0.005 e/p/s
- 16 bit CameraLink output
- Very high QE: >90% peak

Applications:

- Synchrotron and beamlines
- X-ray diffraction
- X-ray spectroscopy
- Plasma physics
- Holography and lithography



Signal Recovery's 7124 precision lock-in amplifier

Signal Recovery and Lastek are proud to introduce the model 7124 precision lock-in amplifier with unique fibre optic link to prevent digital switching noise entering the experiment. The 7124 precision lock-in amplifier is the new standard for measurements in low temperature physics, electrical engineering, electrochemistry and optics.

Specifications:

- Unique analog fibre optic link between the RCU connection module and the main console
- No digital clock or switching noise present at the RCU connectors
- 0.5 Hz to 150 kHz operating frequency range
- Voltage and current mode inputs
- 1.0 MHz main ADC sampling rate
- 10 µs to 100 ks output filter time constants
- Precision DDS sinewave oscillator with adjustable amplitude and frequency
- Harmonic measurements up to 127 × F
- Dual Reference, Dual Harmonic and Virtual Reference operating modes
- Easy manual operation using large full-colour display
- Auxiliary analog and digital inputs and outputs
- Internal data buffer for logging instrument outputs
- USB, RS232, and Ethernet computer interfaces

For more information please contact Lastek at sales@lastek.com.au or 08 8443 8668

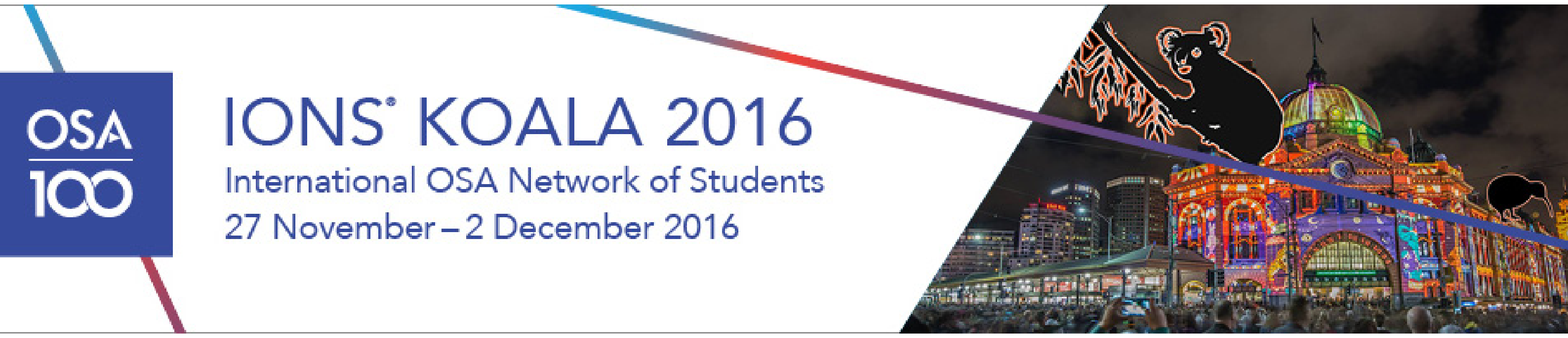
Solartron Analytical introduces the Apps-Lab XM Series

Solartron Analytical's new Apps-XM series of Xtreme Measurement products are each precisely focused on the requirements for specific applications. These exciting new products have a much smaller footprint than most competitive units - delivering unmatched XM measurement performance while taking less of your restricted lab space. Each XM module is individually calibrated using Solartron Analytical's unique multi-point calibration and tested to rigorous standards ensuring best accuracy.

Systems available:

- EnergyLab XM: battery, fuel cells, supercapacitors
- EchemLab XM: corrosion/coatings and Physical Electrochemistry
- SolarLab XM: solar/PV cells
- MaterialsLab XM: dielectrics, insulators and electronic materials

For more information please contact Lastek at sales@lastek.com.au or 08 8443 8668



SPIE. Membership

YOUR RESOURCE. YOUR SOCIETY.

WWW.SPIE.ORG/MEMBERSHIP

SPIE Offers

NETWORKING	TIMELY	PEER-REVIEWED
At 25 international conferences annually	Proceedings published 2-4 weeks after conferences	Papers in 10 exclusive SPIE journals
	AVAILABLE IN THE SPIE DIGITAL LIBRARY	

EDUCATION	CAREERS	STUDENTS
Courses available at conferences, online, and on CD/DVD	International job board w/global salary report	Scholarships, travel grants, chapters, and workshops

Membership Benefits

- 10 free SPIE Digital Library downloads per year
- Full and unlimited access to one SPIE journal of your choice
- Complimentary Online SPIE Course
- Additional discounts on publications, conferences, and courses
- Complimentary quarterly SPIE Professional magazine
- Access to online directory of 17,000+ SPIE members

Individual Options

	1 Year	3 Year	Lifetime
Regular	$105	$297	$995
Early Career Professional	$55	$150	
Retired	$45		
Student	$20		
Pre-College	$0		

For information on Special Consideration Nations
visit: www. spie.org/sc

MAKE SPIE YOUR RESOURCE
JOIN TODAY

SPIE INTERNATIONAL HEADQUARTERS
PO Box 10
Bellingham, WA 98227-0010 USA
Tel: +1 360 676 3290 / Fax: +1 360 647 1445
help@spie.org

www.spie.org/membership

AUSTRALIAN OPTICAL SOCIETY

ABN 63 009 548 387

2017

Subscription Renewal Form

Please check all details before returning completed form by 30 November 2016

Name & address

Title | *Initials*

First Name(s)

Surname

Employer/Institute/Company

Telephone Number

Fax Number

Email

URL

Affliliations — *AIP* ☐ *OSA* ☐ *SPIE* ☐

Main Activities (number up to three in order of importance)

First ☐ *Second* ☐ *Third* ☐

1 astronomical optics	8 optical design	15 nonlinear optics
2 atmospheric optics	9 optical physics	16 teaching
3 communications and fibres	10 radiometry, photometry & colour	17 holography
4 electro-optics	11 spectroscopy	18 (......................................)
5 fabrication and testing	12 thin films	19 (......................................)
6 information processing	13 vision	20 (......................................)
7 lasers	14 quantum optics	

Financial in: *Date of joining:*

Subscription Rate (includes GST): Corporate $350 p.a. Member $50 p.a. Student : $20 p.a.

PAYMENT METHOD *(Please tick box)*

☐ ***Electronic Transfer (preferred)***- BSB: 062195, A/C: 00904008
Important: Include your name in the transaction details.

☐ *Cheque (payable to "THE AUSTRALIAN OPTICAL SOCIETY") Credit*
☐ *Card - please provide details:*

Send payments to:

A/Prof Baohua Jia
Treasurer, AOS
Centre for Micro-Photonics
Swinbunre University of Technology, VIC 3122, AUSTRALIA Fax: (+61)(0)3 9214 4819
Email: bjia@swin.edu.au

If paying by credit card please complete ALL boxes in this authorization. Incomplete forms cannot be processed.

EXPIRY DATE /

CARD NUMBER

NAME ON CARD

AMOUNT **A$**

SIGNATURE

DATE

* Please do not staple cheques onto this form; use a paperclip instead.

Index of Advertisers

Corporate Member Address List

AFW Technologies Pty Ltd
First floor, No. 45, Star Crescent
Hallam, Victoria 3803
Tel: +613 9702 4402
Fax: +613 9702 4877
sales@afwtechnology.com.au
http://www.afwtechnology.com.au

BAE Systems
2-6 Ardtornish Street
Holden Hill, SA 5088
Tel: +618 8266 8284
peter.whitteron@baesystems.com
http://www.baesystems.com.au

Coherent Scientific Pty Ltd
116 Sir Donald Bradman Drive
Hilton, SA, 5033
Tel: (08) 8150 5200
Fax: (08) 8352 2020
sales@coherent.com.au
http://www.coherent.com.au

CUDOS
School of Physics,
University of Sydney, NSW, 2006
Tel: (02) 9351 5897
Fax: (02) 9351 7726
martin@physics.usyd.edu.au
http://www.cudos.org

Ezzi Vision Pty Ltd
Vacuum & Thin Film Coating
PO Box 206, Chirnside Park, VIC 3116, Australia
Office: 1 Dalmore Drive, Caribbean Business Park,
Scoresby, VIC 3179, Australia
Tel: +61 (0) 3 97270770
Fax: +61 (0) 3 86101928
adil.adamjee@ezzivision.com.au
www.ezzivision.com.au

Laser SOS Ltd
Unit 3, Burrel Road, St. Ives, Cambs,
PE27 3LE, United Kingdom
Tel: +44 1480 460990
Fax: +44 1480 469978
sales@lasersos.com
http://www.lasersos.com/

Lastek Pty Ltd
10 Reid Street
Thebarton, SA, 5031
Tel: (08) 8443 8668
Fax: (08) 8443 8427
sales@lastek.com.au
http://www.lastek.com.au

Photon Scientific
114 Albany Drive
VIC 3170
nish@photonscientific.com.au
http://www.photonscientific.com.au

Raymax Applications Pty Ltd
PO Box 958,
Newport Beach, NSW, 2106
Tel: (02) 9979 7646
Fax: (02) 9979 8207
sales@raymax.com.au
http://www.raymax.com.au

Warsash Scientific Pty Ltd
PO Box 1685, Strawberry Hills
NSW, 2012
Tel: (02) 9319 0122
Fax: (02) 9318 2192
sales@warsash.com.au
http://www.warsash.com.au

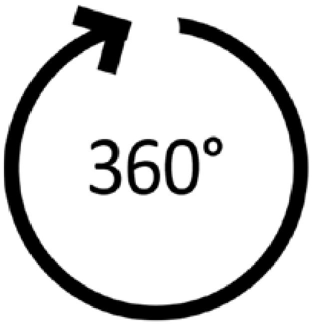
Wavelength Opto-Electronic Pte Ltd
Blk 2, Bukit Batok St 24
#06-09 Skytech Building
Singapore 659480
Tel: 65-65643659
Fax: 65-65649627
john@wavelength-tech.com
http://www.wavelength-tech.com

PHOTON SCIENTIFIC

SCANCUBE , FRANCE

ScanCube is an European manufacturer of photo studios for creating automated 360 and 3D animations for a range of consumer products. The entire system is fully controlled and automated by state of the art software to meet specific imaging requirements. These solutions are leading marketing tools to create quality and professional images for the products which fit in. Applications are unlimited, forensic, documents bird’s eye, physical analysis, website, catlogue ,ecommerce etc.

SCANCUBE



Online team at ZOMP Shoes says
“Since purchasing ScanCube we have been able to reduce our spend on photographers and graphic designers, freeing up our marketing budget for other activities. Furthermore, we are able to get new products, photographed and up on our website much faster than before and due to the integrated software, our photos are far more consistent in terms of size, colour and base line. The Scan cube was easy to set up, and even easier to use. The post production suite is simple, user friendly, and effective – there’s no need to use other post production programs.”

VISIT OUR WEBSITE
www.photonscientific.com.au

CONTACT US
E-mail: info@photonscientific.com.au
Ph: +61 (0)411198392

Fibre Optic & Photonic products

Optical Fibre Delay Line / Spools

AFW can manufacture compact size, robust fibre delay lines to suit your space and budget. You no longer require large fibre spools with connectorised fibre pigtails. We can make customised fibre length solutions to suit your application. Suitable for optical network testing and analysis, time delay applications, fibre network simulations, research and development.

Key Features

- Insertion loss 0.3 ~ 0.5dB per km
- Customised fibre lengths: 50m,100m, 200m, 1km ~ 5km, 10km, 25km, 40km and 50km
- Operating wavelength range: 1260 ~ 1650nm standard
- Fibre type: G.652.D SMF
- Multiple fibre lengths in 19" 1U Chassis

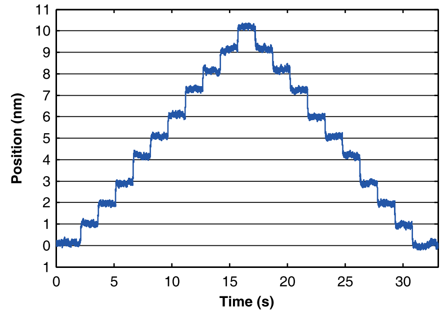
AFW
AFW Technologies

Phone: +613 9702 4402
Email: sales@afwtechnologies.com.au
www.afwtechnologies.com.au

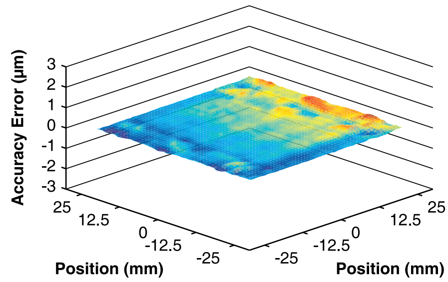
AEROTECH®

Nanopositioners

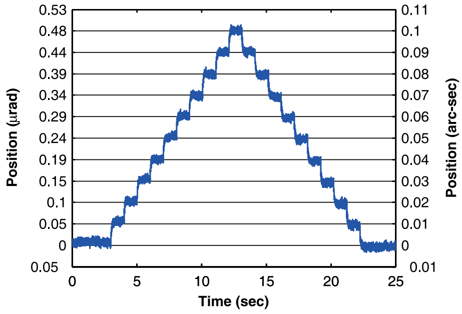
Linear Stages, Rotary Stages, Vertical Lift & Z Stages, Goniometers



ANT95-L 1nm step plot



ANT95-XY-ULTRA 2D accuracy plot



ANT95-R 0.01 arc-sec step plot

Aerotech linear nanopositioners offer:

- 1nm resolution
- <1nm in-position stability
- +/-75nm repeatability
- +/-250nm accuracy
- Up to 160mm travel

Aerotech rotary nanopositioners offer:

- 0.01 arc-second resolution
- 0.005 arc-second in-position stability
- 1.5 arc-second repeatability
- 3 arc-second accuracy
- 360° continuous or limited travel

(08) 8150 5200
sales@coherent.com.au
www.coherent.com.au

Coherent SCIENTIFIC