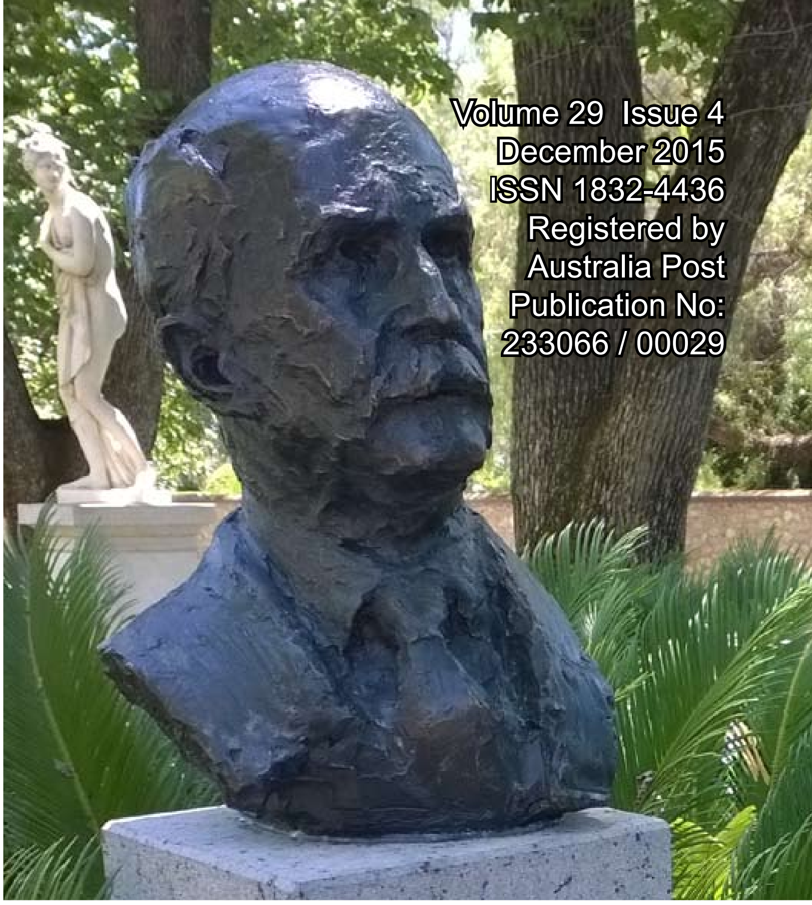
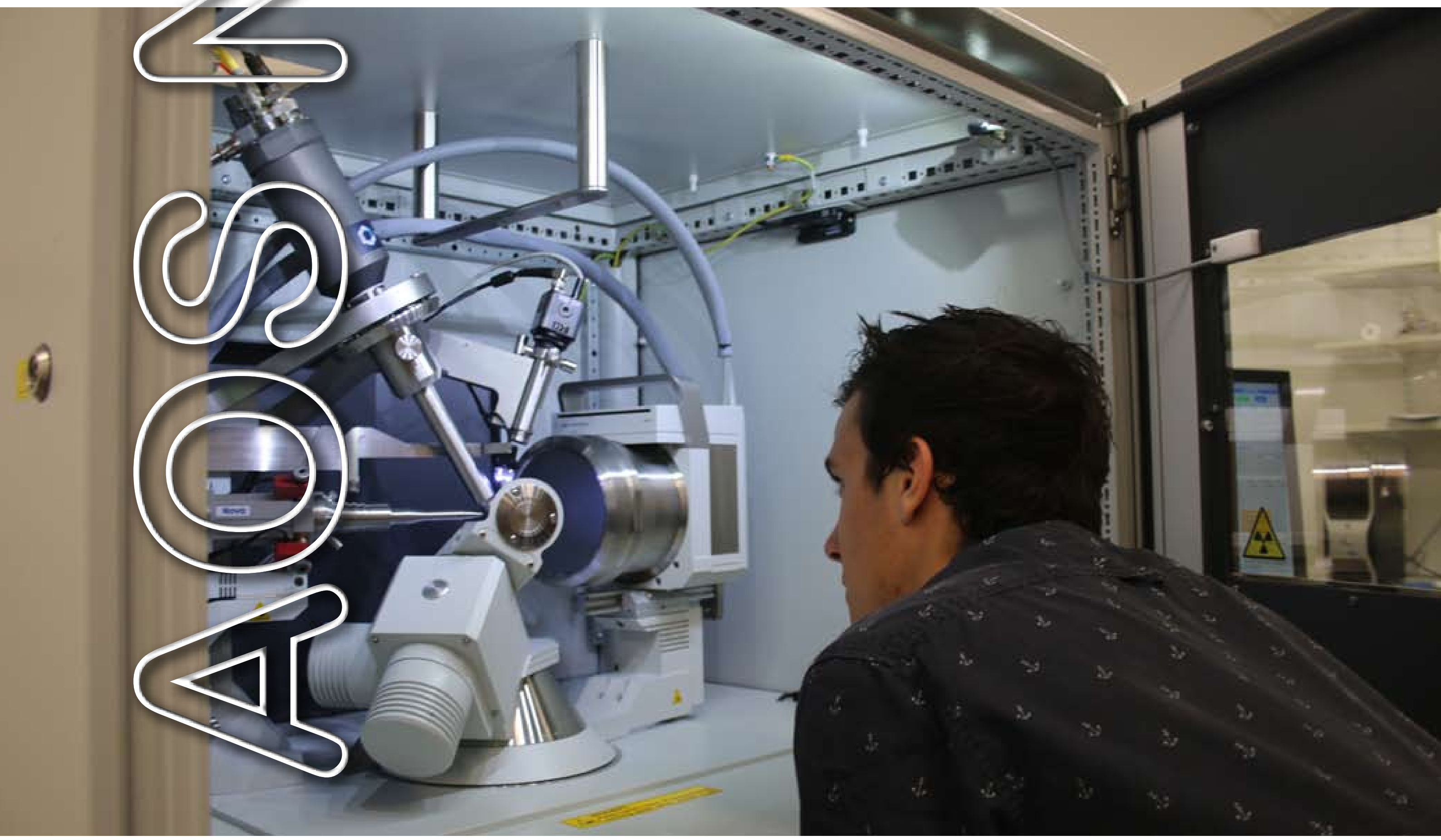
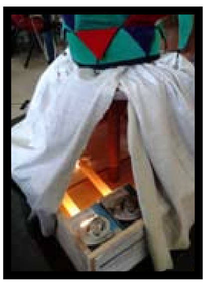
AOS News

Volume 29 Issue 4
December 2015
ISSN 1832-4436
Registered by
Australia Post
Publication No:
233066 / 00029





AUSTRALIAN OPTICAL SOCIETY



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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.

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
- News Item
- Book Review
- Cartoon or drawing

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 editorial board. 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 welcomed, and should contact the editor.
Rates: Under Review
Places may be booked for placing ads - this attracts a 10% surcharge. Black and White in main body of newsletter - free to corporate members.

Copy Deadline
Articles for the next issue (March 2016) should be with the editor no later than 15 February 2016, advertising deadline 8 February 2016.

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Cover Pictures:

- Upper left: Instruments such as this Campbell and Stokes sunshine recorder need smooth optical surfaces. How these surfaces are produced is described on page 27. Image credit: Bidgee under Creative Commons Attribution 3.0 Unported licence. https://creativecommons.org/licenses/by/3.0/deed.en.
- Upper right: A bust of Sir William Henry Bragg was recently unveiled, see page 15. Image credit: Ann Roberts.
- Lower: A high school student looks at an x-ray generator as part of the Growing Tall Poppies program, see page 32. Image credit: Jessica Kvansakul.
- Insets (left to right)
  - There were many student demonstrations, such as this one on refraction at the light themed Science Talent Search, see page 30. Image credit: Stephen Collins.
  - Hans Bachor and Patrick Helean present the public show 'Lasers can do anything' as an IYL event hosted by the UWA OSA student chapter, see page 12.

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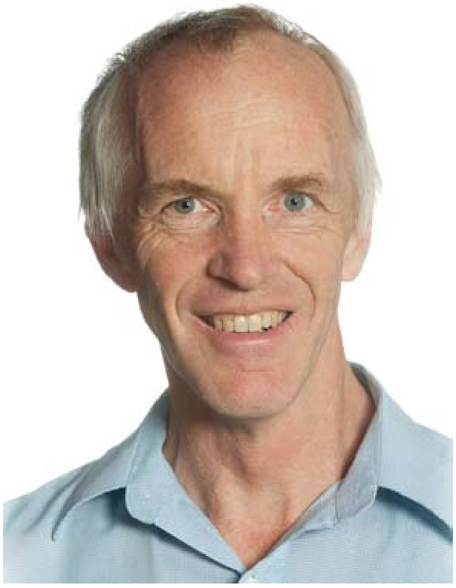
President's Report



I am writing this upon my return from ANZCOP 2015, the Australian and New Zealand Conference on Optics and Photonics 2015, which was held at the University of Adelaide last week (Sunday 29 November to Thursday 3 December). This campus is no stranger to standalone optical conferences, having hosted ACOLS/ACOFT in Nov/Dec 2009 and the AOS Conference in Dec 1997. Like ANZCOP 2013, held in Perth in 2013, ANZCOP 2015 integrated two longstanding conference series, the Australian Conference on Optics, Lasers and Spectroscopy (ACOLS) and the Australian Conference on Optical Fibre Technology (ACOFT). Delegates were treated to a wide variety of talks and posters of a high standard, with the plenary sessions and one of the streams being held in the very comfortable Braggs lecture theatre, with lunches and morning and afternoon teas plus a technical exhibition being located a short walk away in Bonython Hall. Ursula Keller, ETH Zurich was the Frew Fellow. We were delighted to welcome the President-elects of our international partner societies, Alan Wilner representing OSA and Bob Lieberman representing SPIE, with each of them speaking about their own research interests. Alan Wilner, who's from the University of Southern California, spoke on "High-capacity free-space optical communications using multiplexing of multiple orbital-angular-momentum modes", whilst Bob Lieberman, who has primarily worked in industry, spoke on "Optical fiber sensors - submicron to suprakilometer". The conference dinner was held at the Adelaide Oval (the cricket had finished earlier in the week!), a most enjoyable venue, with John Love providing his account of the history of ACOFT (in honour of this being the 40th ACOFT). On behalf of AOS Council I particularly want to thank one of our Council members, Peter Veitch from the University of Adelaide who was the General Chair, a very demanding role. He was very ably supported by Andre Luiten (University of Adelaide) and John Arkwright (Flinders University), as the ACOLS and ACOFT Program Chairs, respectively. Despite the attendance being less than anticipated, the meeting was a resounding success.

ANZCOP 2015 was also a great opportunity to highlight our prizes for 2015, as announced in the previous AOS News. Joss Bland-Hawthorn (W.H. Beattie Steel Medal winner), from the University of Sydney, delivered a plenary talk "Astrophotonics: the Future of Astronomical Instrumentation", Marcus Doherty (Geoff Opat Early Career Researcher award winner), from ANU, spoke on "Diamond quantum microscopy" and Katie Chong (AOS Postgraduate Student Prize winner), also from ANU, spoke on "Wavefront control with metadevices based on dielectric Huygens metasurfaces". The recipient of last year's W.H. Beattie Steel Medal, Tanya Monro, who is now at the University of South Australia, was presented with her award at the closing ceremony. Please remember that applications for the 2016 awards, including the Technical Optics Award, are due in early 2016.

The conference was suitably timed to include the AGM for AOS. Existing Council members were re-elected unopposed, namely Ken Baldwin, Baohua Jia, Robert McLaughlin, Halina Rubinsztein-Dunlop and Peter Veitch; their terms conclude at the AGM in 2017. At the AGM Life Membership of AOS was announced for Ross McPhedran, Jim Piper and Brian Orr, commencing in 2016; this acknowledges their important contributions to the AOS over an extended period. (In the week prior to our AGM Jim Piper became President of Science & Technology Australia (STA).)

As the year draws to a close I am aware of ongoing IYL 2015 activities around the country. It was pleasing to see that the Science Teachers' Association of Victoria Science Talent Search for 2015 was based on the theme "Science of Light" (see my article in this edition). The planned international events to conclude the year look very interesting. As I noted previously, AOS Council is considering the development of an updated "roadmap" for optics and photonics in Australia; your ideas are welcome! The announcement of a new innovation strategy by the government this week is very welcome, and underscores the importance of such a "roadmap".

In the last week of November some of our student members participated in the 7th annual KOALA-IONS conference held in Auckland, for which AOS was a silver sponsor. Once again the students are congratulated on their efforts. Planning is well underway for conferences scheduled for 2016. The OSA will be running its Photonics and Fiber Technology conference 5-8 September in Sydney; this incorporates the BGPP (Bragg Gratings, Photosensitivity and Poling in Glass Waveguides), NP (Nonlinear Photonics) and ACOFT conferences. The AOS annual meeting will be held 4-8 December in Brisbane, as part of the 22nd Australian Institute of Physics Congress; this will be held in conjunction with the 13th Conference of the Association of Asia-Pacific Physics Societies. Beyond next year, another ANZCOP is likely to be held at the end of 2017.

I would like to wish all AOS members the very best for the festive season and for your endeavours for 2016.

Stephen Collins
AOS president

Editor's Intro

Welcome to the final issue of AOS News for 2015. I'd like to thank everyone who contributed articles and news items throughout the year to AOS News. In particular I'd like to thank Tony Klein, who always manages to supply a fascinating item for the Optics in Everyday Life section, and Stephen Collins and Ann Roberts who have great suggestions for news items and for people to approach for articles. Baohua Jia has done an excellent job of dealing with the financial and membership side of things, after taking over from Simon Fleming as Honorary Treasurer, so thanks to her as well. As you will see in this issue, Shelley Martin has also been a great help on the financial side for many years, and has continued to assist this year whilst transferring over to Baohua, so thanks a lot to Shelley as well.

We have a range of articles for this issue, with a conference report from the WOMBAT meeting in Sydney and details of how some of the optical equipment produced in Adelaide by BAE Systems played a vital role in finding trapped miners in Chile in 2010. Other items in this issue include details of more International Year of Light events that took place at UWA, a report from the Victorian Science Talent Search that was light themed this year and information about the Growing Tall Poppies outreach program to high school students. Our 'Optics in Everyday Life' section looks at how high quality optical surfaces are produced, and there is also an article on Australia's participation in the early years of laser development. I hope you enjoy reading them all. As usual, please let me know if you have any suggestions for AOS News or have any articles or other items you would like to submit. We are considering having some themed issues for AOS News next year, so if you have any ideas for themes please let me know. Current thoughts are to have an optics in astronomy/space research theme for the March issue, and a biophotonics theme for the June issue as these are topics we don't often hear about in AOS News, but that a growing number of Australian groups are involved in. If you would like to submit an item on either of these topics please let me know. The submission deadlines are 15 February for the March issue and 16 May for the June issue. We will still accept articles in these issues that are not related to the themes, so I look forward to seeing submissions on all topics related to optics next year.

I have recently become involved in the Growing Tall Poppies program that aims to encourage high school students and particularly girls to consider study in physics at VCE and university level. As you will see in the article in this issue, it is a targeted outreach program that acts as an intensive introduction to science and scientists at universities in order to generate interest in physics, see how it is connected to other science disciplines and give the students an idea of what scientists are really like. I am a strong proponent of the need for outreach and think it is great that there are so many programs available that involve different levels of participation and types of interaction so that many people can be reached. The International Year of Light was a perfect opportunity for outreach in the community, and hopefully we can continue to work with the general public in these ways to help them see why science is important.

In discussions with others involved in running the Growing Tall Poppies program we realised that not everyone feels comfortable in their own physics departments and that female students can feel that they aren't viewed as having the same abilities as their male counterparts. Whether this is really the case or not, the fact that the students feel this way is something to think about. Some of the research that the Growing Tall Poppies program was based on has shown that in general girls need to feel more of a connection with a topic for them to want to pursue it - they want to know why it is important and how it relates to them. I think it can be hard for us as people who already chose this career path, perhaps especially if we are female, to realise that this is the case in general as our own experience probably doesn't reflect this, so it is important to take note of these findings. One of the answers to this issue seems to be to help break stereotypes held and make people realise that anyone can succeed in STEM areas and that not all physicists are older, white men. The '#iLookLikeAnEngineer' campaign was one great way to start this as there were images spread on social media showing people of all ages and backgrounds so that people see the diversity that exists and can identify with this. Hopefully there can be more campaigns like this that help people to see that STEM subjects are open to everyone from all backgrounds.

We also discussed the fact that in physics there tends to be reticence for people who identify as lesbian, gay, bisexual or transgender (LGBT) to be open about this and the fact that many minorities are underrepresented in physics. It is up to us to reflect on this and try to make sure we are welcoming. In the March issue of Physics Today there was an article about a committee looking into issues relevant to members of the American Physical society who identify as LGBT to see if they are underrepresented and what problems they may face. There will be a report on the results of this coming out early next year, so it will be interesting to see if they have any useful suggestions.

I hope you enjoy this issue of AOS News, and wish you all the best for 2016,

Jessica Kvansakul
Editor

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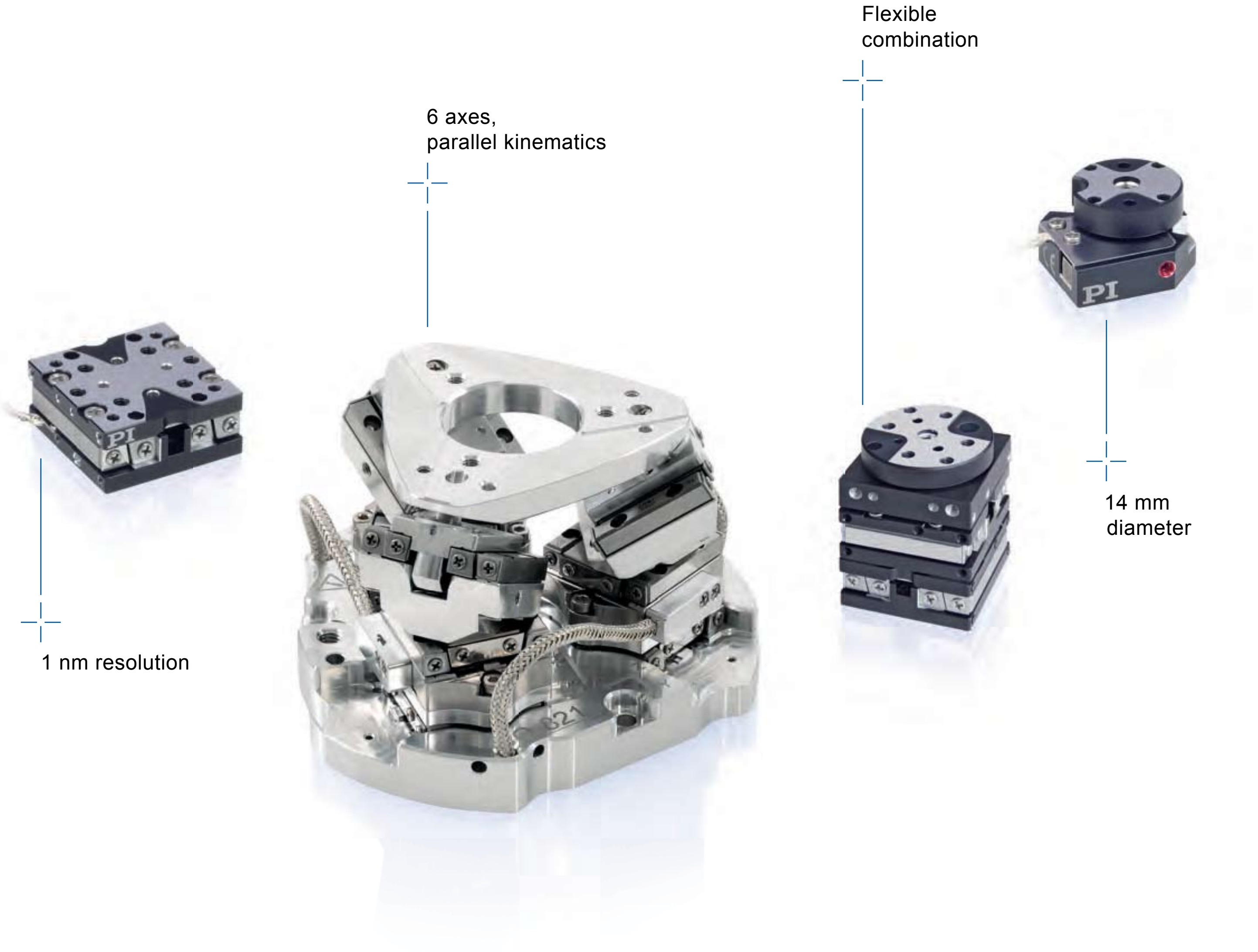

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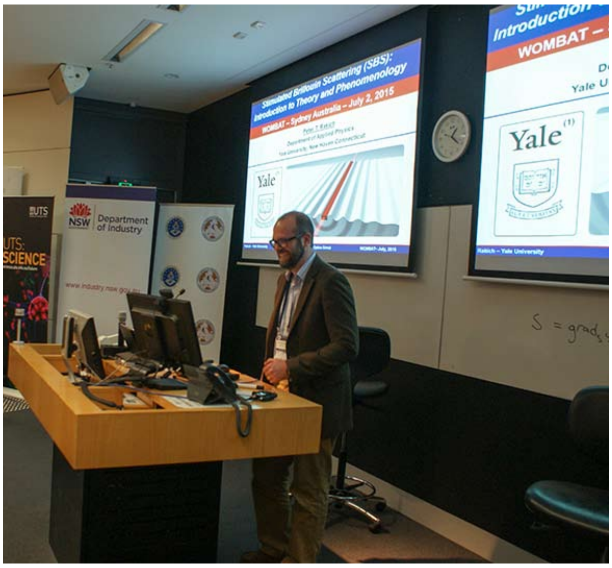
Popular Mechanics: The Workshop on Optomechanics, Brillouin scattering, Applications and Technology (WOMBAT 2015)

by Christopher G. Poulton and Benjamin J. Eggleton

For three days in July, Sydney was host to a new international meeting, entitled WOMBAT, which brought together top researchers in optomechanics and Brillouin scattering in a single forum for the first time.



Professor Peter Rakich prepares his tutorial presentation.

The interaction between mechanical vibrations and light has a long and distinguished tradition in the history of physics, involving famous names such as Brillouin and Mandelstahm, Braginsky, Chiao and Townes. However, the modern study of optomechanics has proceeded along two parallel paths that are only now beginning to converge: First is the study of the quantum nature of vibrations and how these interact with light; the second path involves Brillouin scattering, which is the coherent interaction between light and travelling vibrations in optical waveguides. Although both fields study essentially the same phenomenon they do so from distinctly different viewpoints.

From 20th to 22nd of July 2015 researchers gathered in Sydney to bridge the gap between these two fields. This new meeting, whimsically entitled WOMBAT, provided a comprehensive overview of the field of Brillouin scattering and optomechanics, covering theoretical principles, recent technological advances, applications, and user perspectives. The event attracted 74 attendees, including a broad mix of students, researchers, local and international speakers.

The first day, held at the University of Sydney, consisted of a series of tutorial lectures covering the fundamentals of several different research areas, ranging from basic theory to modern applications. Guest speakers, including Professor Peter Rakich (Yale) and Professor Gaurav Bahl (Illinois), covered a range of topics from the history of the field, the fundamentals of elasticity theory and phonon-photon interactions, and the phenomenology leading to recent experiments. These extremely popular sessions were not only of great benefit to students but also helped establish a common framework between researchers in the days ahead. The day was capped by a widely acclaimed public lecture given by Professor Kerry Vahala (CalTech), who talked about the impact and importance of resonators in modern photonics.

Days two and three of the meeting, held on Sydney harbour, comprised presentations of cutting-edge research that span the field, from new breakthroughs in theory to the latest in fabrication and experiment. Keynote Speaker Professor Gaurav Bahl spoke about his ground-breaking work on Brillouin scattering in resonators. New results exhibiting efficient SBS in silicon – a major goal in the field – were presented both by Professor Rakich and Mr Raphael van Laer (University of Ghent), the latter giving details of exquisite new structures for

Professor Kerry Vahala presents his keynote talk on Wednesday.

the harnessing of the effect in very short lengths. New results on optical fibres were presented by Dr Jean-Charles Beugnot (CNRS, France) and by Mr Johannes Koehler (Max Planck Institute, Germany). In his keynote address, Professor Kerry Vahala talked about the multifarious uses of optomechanical effects in extremely high-Q resonators.

Further topics ranged from advanced structures for enhanced SBS, unconventional material systems, to applications in radiofrequency signal processing. Many of the sessions resulted in enthusiastic participation of attendees during the presentations, and the coffee breaks were noted for their intense discussions. These interactions continued over lunch, which took place directly on Sydney Harbour. The welcome reception for the attendees (sponsored by Keysight) was opened by NSW Chief Scientist Mary O'Kane, who gave a widely appreciated address on the importance of fundamental science and its role in underpinning industrial and economic progress.

Overall the event was a great opportunity for researchers at the cutting edge of optomechanics research to come together in a relaxed environment, and many attendees expressed great enthusiasm for WOMBAT II, due to be held in 2016 or 2017.

Professor Ben Eggleton together with Professor Kerry Vahala and NSW Chief Scientist Mary O'Kane.

Christopher G. Poulton is with the School of Mathematical and Physical Sciences, University of Technology, Sydney and Benjamin J. Eggleton is Director of CUDOS, ARC Centre of Excellence and is with the Institute of Photonics and Optical Science (IPOS) and the School of Physics, University of Sydney.

WOMBAT delegates outside the venue.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INSPIRED WORK

Shining the Light at the University of Western Australia

by Danuta Bukowska and Andrea Curatolo

The 2015 International Year of Light and Light-based Technologies, an initiative supported by the United Nations, has inspired young researchers and students from the University of Western Australia.

Ben Eggleton giving the first in the LightTALKS public lecture series.

Following their passion for optics and educational outreach students from UWA founded a student chapter of The Optical Society of America (OSA) at the beginning of the year. Their aim was clear: to provide year-round events that educate and promote public awareness of the widespread use of optics and light-based technologies in science, engineering, medicine and arts. The chapter had many interesting ideas on how to showcase the power of harnessing light to the Western Australian community.

Their first event, called The Light TALKS, was a public lecture series where scientists and artists talked about optics and light at The University of Western Australia (UWA). This event was co-organised by the Institute of Advanced Studies at the University of Western Australia, Lions Eye Institute, The Optical Society and SPIE, the international society for optics and photonics. Three separate lectures were presented in August, September and October 2015. The first one was given by Professor Benjamin J. Eggleton, director of the ARC Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS), a Fellow of the Optical Society of America, member of SPIE, and past President of the Australian Optical Society. In his talk, Professor Eggleton brought the local community closer to the role that light plays in advancing technology that we use every day. One month later, Professor David Mackey, Managing Director of the Lions Eye Institute and Director, Centre for Ophthalmology and Visual Sciences at UWA took the audience on a beautiful journey to discover, at the end, that seeing is not always believing. He showed the wealth of different factors, from the anatomy and physiology of our eyes, determining the way we perceive colour and influencing what we see in the mirror, through to genetics, environment and age. In the last talk of the series, Rebecca Baumann, a very talented Western Australia artist, who exhibited both nationally and internationally, demonstrated how light not only shapes and influences our perception, but also how light can transform the environment around us and become the object of an artwork. About 300 people attended the LightTALKS lecture series with a keen interest to learn about the wonders of light and its use.

Hans Bachor and Patrick Helean present 'Lasers can do anything'.

The Western Australian public did not have to wait long to be taken for another beautiful journey into the world of light. In November, the OSA student chapter organised an outdoor event: Lasers can do anything, an exciting public show with fun demonstrations of the power of lasers and their wide-spread use in the most varied fields, presented by Emeritus Professor Hans Bachor and Patrick Helean. Hans Bachor is a pioneer of quantum optics in Australia based at the Australian National University (ANU). He was made a member of the order of Australia for his contributions to research, education and youth programs in the field of optics. He is a Fellow of the Optical Society (OSA) and of the Australian Academy of Science. Patrick Helean has a wealth of experience in theatre production, science communication and the art of explaining science in the most effective and exciting ways. He is leading the excited particles, the team of demonstrators and presenters at Questacon, the Australian National Science and Technology Centre located in Canberra. Both have an interest in making science more relevant to most in the society, to students, parents, teachers and decision makers in commerce and

David Mackey with OSA members.

politics. Their show intrigued over 180 people of all ages under a warm starry sky, explaining the fundamental properties of light and lasers, and the potentials of a 50 year old invention gone from being a solution in search of a problem to a multi-billion dollar industry. This event was so popular that the UWA OSA student chapter had to organise a repeat event the following day, also sold out and attended by more than 100 people.

The members of the UWA OSA student chapter were driven by their passion for optics, enthusiasm, creativity and team-work to promote the International Year of Light in Western Australia. However, this outreach effort could have not been possible without the financial support provided by the Optical Society and the International Society for Optics and Photonics (SPIE) that awarded the University of Western Australia a 2015 SPIE Education Outreach Grant. Organisational support was provided by the Institute of Advanced Studies at the University of Western Australia and Lions Eye Institute.

For more information, see:
http://uwa.osahost.org/ and
youtube.com/watch?v=xnx3RrXpu7k

About us: The University of Western Australia student Chapter of the Optical Society was established in 2015. Professor David Sampson, Head of the Optical+Biomedical Engineering Laboratory (OBEL) and Director of the Centre for Microscopy, Characterisation and Analysis (CMCA) is the Faculty Advisor for the Chapter and Dr Danuta Bukowska, Research Associate at the Lions Eye Institute supervises the Chapter outreach activities in her Outreach Advisor role. Andrea Curatolo, PhD student at OBEL is the current Chapter president. He coordinates all the actions, keeps deadlines and inspires chapter members to get involved.

Danuta Bukowska is with the Lions Eye Institute, and Andrea Curatolo is with the Optical+Biomedical Engineering Laboratory, University of Western Australia.

INTERNATIONAL YEAR OF LIGHT AUSTRALIA 2015

Conferences

7-11 February 2016 ICONN 2016

The International Conference on Nanoscience and Nanotechnology 2016 will be held at the National Convention Centre, Canberra from 7 to 11 February 2016. The aim of ICONN 2016 is to bring together Australian and International communities (students, scientists, engineers and stake holders from academia, government laboratories, industry and other organisations) working in the field of nanoscale science and technology to discuss new and exciting advances in the field. ICONN will cover nanostructure growth, synthesis, fabrication, characterization, device design, theory, modeling, testing, applications, commercialisation, and health and safety aspects of nanotechnology. ausnano.net/iconn2016

ICONN 2016

5-8 September 2016 BGPP, NP and ACOFT

The Bragg Gratings, Photosensitivity and Poling in Glass Waveguides (BGPP), Nonlinear Photonics (NP) and Australian Conference on Optical Fibre Technology (ACOFT) will be held in Sydney from Monday 5 to Thursday 8 September 2016 in conjunction with the OSA. BGPP addresses all aspects of grating structures, photosensitivity, glass relaxation and poling in optical fibre and waveguides from physical fundamentals, properties and fabrication approaches to applications. The Nonlinear Photonics meeting is a venue for researchers interested in all aspects of nonlinear optical processes in structures, devices and systems. ACOFT addresses all aspects of guided wave optics including the theory, materials, technologies and applications associated with waveguide devices and integrated photonics. osa.org/en-us/meetings/optics_and_photonics_congresses/photonics_and_fiber_technology

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

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.

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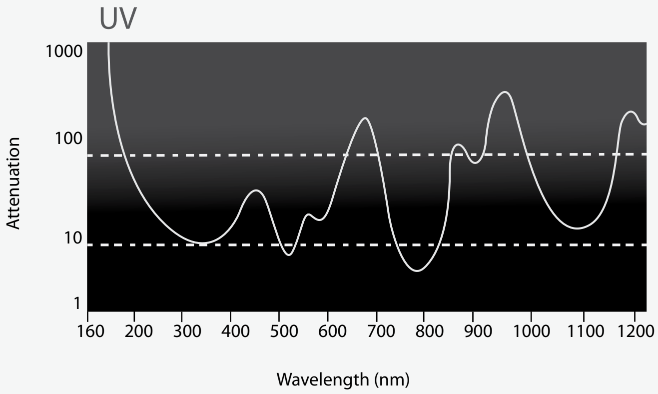
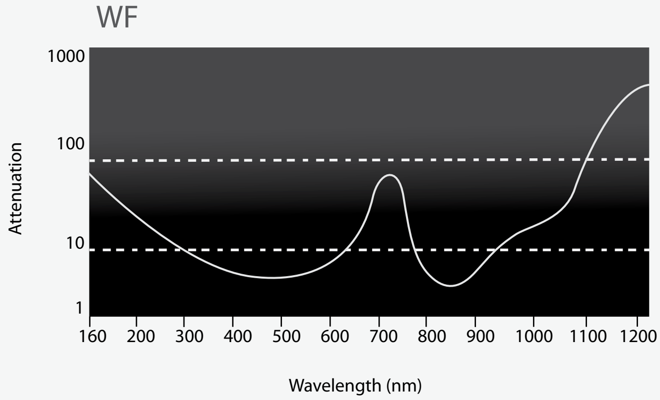
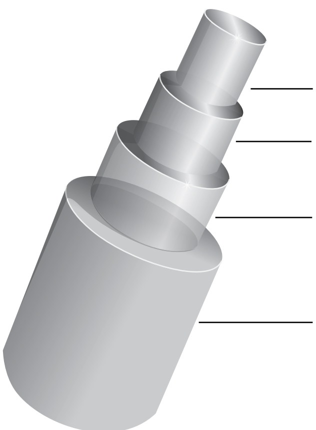
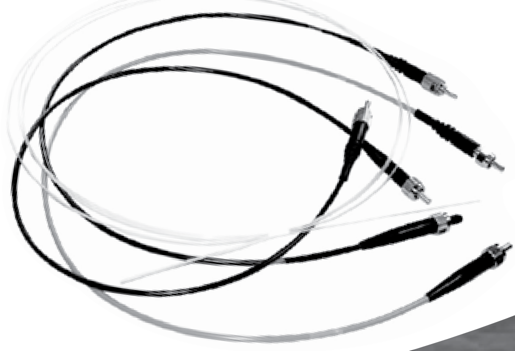
Nuclear plasma diagnostics	
Analytical instruments	1 to 3 meter or custom lengths
Laser diode pigtailing	FC, SMA 905 or ST type connectors
Semiconductor capital equipment	FC, ST or SMA adaptors









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News

New life members of AOS

Ross McPhedran

Jim Piper

Brian Orr

INTERNATIONAL YEAR OF LIGHT 2015 AUSTRALIA

In the International Year of Light, the AOS congratulates Ross McPhedran, Jim Piper, and Brian Orr on their election to Honorary Life Members of the Australian Optical Society (AOS) for their foundational contribution to the Society. Ross and Jim were signatories to the Memorandum of Association that established the AOS as an association in 1983. Jim took over the presidency of AOS in 1984-1985, while Ross was the foundation secretary and the foundation editor of AOS News. Brian was an early member and the AOS president in 1996-1998. Jim is currently serving the broader Science Community and is the current president of Science Technology Australia (STA). All three are recipients of the AOS W.H. (Beattie) Steel Medal; in 2004, 1997 and 2005 respectively. We look forward to their continuing involvement with the Society.

Congratulations to Peter Veitch

The AOS congratulates Council Member Peter Veitch (University of Adelaide) who was recently elected a Fellow of the Optical Society of America.

Sculpture of Sir William Henry Bragg unveiled in Adelaide

A new bust of Sir William Henry Bragg was unveiled at the University of Adelaide on North Terrace on 2 December, next to the existing bust of his son, Sir William Lawrence Bragg. 100 years ago the pair were awarded the Nobel Prize in Physics for the development of x-ray crystallography, the only father and son team to do so. The Royal Institution of Australia (RIAus), Australia's national science channel, arranged for the bust to be commissioned for the centenary of their Nobel Prize win to sit alongside that of Sir Lawrence. Bragg senior spent twenty-three years in Adelaide, before returning to the UK where he was born, so it is fitting that the connection of both Braggs to Adelaide and their achievements can be honoured with these sculptures.

For more information see riaus.org.au/articles/sir-william-henry-bragg.

Busts of Sir William Henry Bragg (left) and Sir Wiliam Lawrence Bragg in Adelaide. Image credit: Ann Roberts.

SPIE News

by Amy Nelson

Dream, be patient, use the fear, advise women photonics professionals in new planner

The SPIE Women in Optics 2016-17 planner has just been released.

"Dream first, try next, and do your best," Juanita Saroj James Asirvatham, research associate at Lancaster University, advises young women who wish to pursue a career in optics and photonics, in the newly released SPIE Women in Optics 18-month planner for 2016-2017.

In the planner, women in STEM (science, technology, engineering, and mathematics) occupations ranging from university professor and laboratory researcher to entrepreneur and CEO share stories of inspiration and discuss the challenges and rewards of careers in fields where females are often a small minority. The planner is available at no charge from publisher SPIE, the international society for optics and photonics.

Asirvatham describes her work at Lancaster University as exploring novel photonic nanostructures to improve the efficiency and economy of solar energy production. "STEM is for creative thinkers," she said. "From my experience, I would say choosing a career in STEM will provide lifelong professional development."

Also featured in the planner is the director of clinical services at Desert Medical Imaging, Bernadette Greenwood. She advises young women in STEM fields to overcome barriers to success by applying logic, sensibility, and patience to any situation.

"My advice to young women is to be patient," she said. "Sometimes it's impossible not to feel discouraged, but stay strong and believe in yourself. Use fear as fuel for action."

At Desert Medical Imaging, Greenwood oversees an MRI-based prostate cancer clinical trial, where the company's unique capabilities and team skills have enabled them to deliver laser interstitial thermal therapy to prostate cancer using thermal mapping with MRI.

Bernadette Greenwood is one of the women featured in the 2016-17 planner.

The planner features some women who work in the optics community but did not receive a STEM education.

Hui (Catherine) Wang, who is the deputy director of the Department of International Cooperation at the Changchun Institute of Optics, Fine Mechanics, and Physics, received her MA in English Literature. Wang said the biggest challenge in her career is not having a scientific background, making her work to increase her knowledge and understanding of optics by reading books and journals, having discussions with colleagues and attending academic conferences.

"I also advise [young girls and women] not to be afraid of difficulties and mistakes," Wang said. "Facing these can make you stronger."

The 2016-2017 planner is supported by Edmund Optics, TRUMPF, Inrad Optics, and illumia.

SPIE Women in Optics promotes personal and professional growth for women through community building, networking opportunities and encouraging young women to choose optics and photonics careers.

Career advice from all of the women profiled in the planner is available on the SPIE website at www.spie.org/x116241.xml. To receive a copy of the planner, email pascale@spie.org.

Two high-level Australian researchers will be featured speakers at SPIE events in 2016

At SPIE Photonics West in San Francisco in February, Halina Rubinsztein-Dunlop, Director of the Quantum Science Laboratory at the University of Queensland, will give the Nano/Biophotonics plenary talk, on applications of optical tweezers.

Professor David Sampson, Director of the Centre for Microscopy, Characterisation and Analysis at the University of Western Australia, will speak during the BiOS Hot Topics session, on deep penetration with needles and alternate contrast with micro-elastography.

Professor Sampson also will give a plenary talk at SPIE Photonics Europe in Brussels next April. The event is the premier research conference in Europe on photonics, optics, lasers, and micro/nanotechnologies, and attracts an international audience.

For more information see SPIE Photonics West and Photonics Europe on the SPIE website, www.spie.org.

Amy Nelson is PR Manager with SPIE.

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BAE Photonics Expertise helps Mine Rescue

by Heather Riddell

Optical parts crafted in Adelaide by BAE Systems were a critical component in the technologies used in the desperate and complex rescue operation to save 33 miners trapped underground for 69 days in Chile in 2010.

The extraordinarily precise laser scan mirrors were an integral part of an advanced laser scanning system developed by another Adelaide-based company, Maptek which designs hardware and software technology for global mining companies.

The I-Site laser scanning system was used to map the topographical surface above the mine to obtain geo positioning information and produce a topographic surface model of the San Jose mine.

The data was combined with historical data and 2D plans in Maptek Vulcan software to create a 3D model of the complex underground workings to understand where the miners were trapped 2,297 feet below.

This enabled the direction and orientation of the drillholes to be identified, allowing an access shaft to be built that finally helped bring the men to safety.

BAE Systems photonics technician, Stewart Williams, says it was a very proud moment when he realised that a piece of technology he helped to create was responsible for saving lives.

BAE Systems technician Stewart Williams manufacturing optical prisms for Maptek's I-Site scanning systems. The I-Site scanning system was used in the rescue of miners trapped underground in Chile in 2010.

BAE Systems is now working with Maptek to help optimise the development of its next generation of Laser Scanners.

BAE Systems diamond turning technology, which is unique in Australia, shaped the laser scan mirrors used in the I-Site laser scanning system. The technology is capable of operating at nanometre levels generating an array of complex aspheric and free-form shapes. The systems are manufactured using the full range of infrared materials, polymers and non-ferrous materials.

BAE Systems diamond turning products have traditionally provided laser rangefinder, thermal imaging and image detection systems for defence customers. BAE Systems also has a growing number of commercial customers from the aviation, resource, forensic, space research, universities and medical sectors who are discovering the advantages of having precision optical components and systems manufactured locally, thereby reducing delivery times, reducing costs whilst providing real term technical support, helping to enable their projects.

"It was a very proud moment when I realised that a piece of technology I helped to create was responsible for saving lives." BAE Systems photonics technician, Stewart Williams.

Heather Riddell is Marketing and Communications Manager with BAE Systems Australia.

Thanks to Shelley Martin

Most of those who serve the Society are visible to the membership, but not all. I want to acknowledge the valuable service that Shelley Martin has provided to the Society over the 5 years I was Treasurer and in the hand-over of the role this year to Baohua Jia. Shelley is the Centre Manager for CUDOS, and Ben Eggleton kindly offered that she could assist me in this role. Shelley developed an excellent financial record-keeping system for us and has run it efficiently and enthusiastically. Thanks Shelley, it was great working with you on this.

Simon Fleming

The Blinding 1960s of Australian Laser Research

by Stuart Jackson

*This article was previously published in Australian Physics **52** (4), 117-120, 2015. Reprinted with permission.*

In the early 1960s Australia's defence research community was quick to realise the potential of the laser as a reliable tool for measurement, testing, bonding and materials modification. Current Australian laser research has a strong international reputation for innovation and I show that this reputation can be traced right back to a time immediately after the invention of the laser itself.

This year we celebrate the international year of light a short time after the celebrations for the 50th anniversary of the invention of the laser back in 2010. This one invention marked the beginning of an enormous number of new fields in science, medicine and engineering and in essence the discoveries and inventions made possible by the laser really underpin the current global celebration of light. The laser, because of its unsurpassed spatial, spectral and temporal resolution, combined with radiance values unmatched by anything else in the universe, has played the central role in photonics. I wonder how Theodore Maiman would feel if he could witness the global impact of his demonstration. In this article I survey the work of the early Australian researchers of lasers, the research that by the 1970s firmly established Australia as a strong contributor to international experimental photonics.

Australia was early in its adoption of the laser as a field of study, with the earliest research focussed primarily on defence applications at the Weapons Research Establishment (WRE) located at Salisbury, South Australia. Gordon Troup (see Figure 1), who is still teaching at Monash University, was the first Australian to engage in maser (later *laser*) research. Ron Hewett introduced Troup to "molecular amplifiers" back in 1956 when he was on a two year appointment to the Royal Aircraft Establishment (RAE) Farnborough, England. The molecular amplifier became Troup's area of research for his MSc at Chelsea College and his supervisor was Dr Eric Houldin. Troup's dissertation was later published into the book [1] "Masers" on October 22nd 1959. In that same year, Jay Ralph Singer published his book on masers [2] so Troup's monograph probably shares the honour of being the first book on lasers, although Troup believes his book was actually published first.

The first contribution to laser development that was based in Australia came in 1959 from theoretical studies also by Troup, after he returned back to WRE [3]. Two more papers were subsequently published between 1960 and 1962 [4,5] all primarily focussed on the fundamental physics of lasers. Troup later became a lecturer in physics at Monash University in 1961 and in 1963 the second edition of his book was published [6].

Australia's first "laser group" formed in 1961 at WRE under the leadership of Fred Thonemann; the group subsequently carried out Australia's first laser demonstration. The laser was designed by Troup and comprised a flashlamp-pumped ruby rod that employed an elliptical pump cavity, which was quite different from Maiman's pioneering demonstration that used a helical flashlamp that surrounded the ruby rod. It is remarkable that in little over a year after Maiman's demonstration, Australia was already making progress in laser development.

Australia's next laser was developed at the University of Tasmania in 1962 during the Honours year of Phillip "Pip" Hamilton, now retired and former DVCR at Deakin University. Pip submitted his thesis "The ruby optical maser" in February 1963 making the dissertation Australia's first thesis in the field of lasers. Pip says "I recall that Ellis [Prof Bill Ellis, Head of Physics] handed me a small plastic box with "Linde Company" on it. It contained a pink, cylindrical rod 8 cm long, 1 cm in diameter, with the ends of the cylinder polished optically flat and perpendicular to the axis of the rod. The rod was made of artificial ruby. Ellis said to me "we thought you might like to build a laser". My task was quite simple really(!): collect together everything that was needed (flash tubes and power supply, a photomultiplier tube with power supply and neutral density filters, amplifiers, large capacitors and power supply to drive the flash tubes, etc.) and then build the laser! After I finally got the thing going, I had to demonstrate its properties – in particular parallelism of the beam, and coherence."

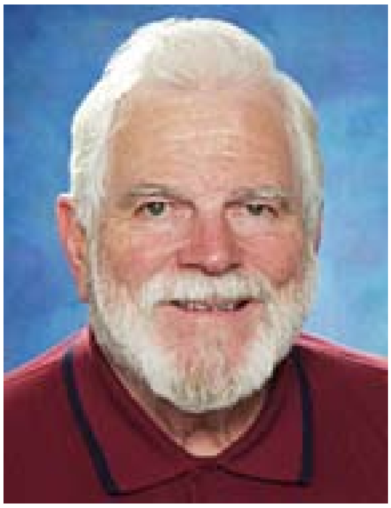

Figure 1. Gordon Troup, now Honorary Senior Research Fellow at Monash University, could be said to be the founder of Australian laser research.

With the field of laser research now firmly established in Australia efforts in laser development expanded to the Defence Standards Laboratories (DSL), Department of Supply, Maribyrnong in late 1963 at the instigation of John Farrands (later Chief Defence Scientist, 1971-77, and Head of the Department of Science and its successors, Department of Science and Environment and Department of Science and Technology 1977-82). This initiative was part of a policy of introducing more basic, open-ended research into DSL. After purchasing a ruby laser from Hughes Research Laboratories in 1963 work began in earnest on in-house development. Early studies investigated phenomena associated with the resonant cavity including the spatial and spectral coherence of the beam. The beam divergence of the ruby laser was thoroughly investigated and work was started on the construction of a high

Figure 2. Photograph from the Annual Report of the Defence Standards Laboratories 1964-1965. The report states "[T]he computer programme for pumping efficiency evaluation has been completed and is being used for cavity design. It has shown that multiple reflections in the cavity are important, up to seven reflections contributing to the absorbed energy." Copy courtesy of Russell Whitcher.

energy pulsed output ruby laser using a Pockels cell as a Q-switch. In early 1964 plans were made to start a long-term programme on laser materials development with an initial emphasis made on organic complexes. During 1965 a lot of work was carried out on numerically modelling the absorption characteristics of the pump light within the ruby rod from the flash lamp light that reflected from diffusely reflecting pump cavities (see Figure 2). The formulation of the numerical model was later published in national [7] and international [8] journals.

Keith Gibbs, now retired from Swinburne University of Technology, worked at DSL during this time and remembers "[i]nitially the work was on ruby lasers in order to gain familiarity with this relatively new technology. A number of devices were constructed using imported [Union Carbide] ruby rods and [linear EG&G] flashlamps but also using the DSL capabilities in the fabrication of various optical components. Studies of pump-cavity design, beam structure, excited-state dynamics and polarization behaviour formed part of this early work. In-house facilities enabled components such as Pockels' Cells, multi-layer reflectors and filters to be readily available and this led to studies of Q-switching phenomena."

Over the years Russell Whitcher, Keith Gibbs and a number of other researchers published their experimental results in the annual report of the DSL. DSL initially produced ruby lasers with an output energy of 5 J and on the basis of these results plans were made to extend the output energy to 50 J. Australia's first laser based paper in an international journal was published in 1965 [9] when Gibbs and Whitcher reported their studies on the polarisation of the output from a roof-top-shaped ruby rod with the c-axis of the crystal aligned perpendicular to the roof edge. After relaxation studies of in-house fabricated saturable dyes such as chloro-aluminium phthalocyanine (CAP) were published in Nature in 1966 [10] by Bill Bowe, Gibbs and J. Tregellas-Wiliams, Gibbs along with Hamish Kellock later discovered in 1967 [11] that laser oscillation in CAP was possible, thus creating the first uniquely Australian laser transition. Amusingly, the photograph of the spectrum of the output was actually published upside down, so this laser rightly deserves the title "the down under laser". DSL's work on Q-switching ruby using Pockel cells was later published in 1967 [12].

With Ruby lasers forming the backbone of Australia's early laser research, it was in 1965 at CSIRO's National Standards Laboratory in Sydney that work was started on the development of helium-neon lasers some 5 years after the pioneering demonstration of that laser. This work was carried out under the leadership of Jack Ramsay, who earlier worked at WRE. The tubes containing the gain medium were made in Adelaide by Scientific Optical Laboratories (SOLA) and were used to demonstrate a single longitudinal mode HeNe laser, which was later published by Ramsay and K. Tanaka (then on leave from the National Research Laboratory of Metrology, Tokyo) in October 1966 [13]. Earlier in 1964, Bill Kricker and William "WIB" Smith from the Wills Plasma Physics Department at the University of Sydney were using a HeNe laser, provided by Ramsay, in a moving-mirror interferometer to measure plasma densities leading to publication in January 1965 [14]. This paper comprised Australia's first study involving the use of a laser that was reported in an international journal.

In 1966/67 the WRE in Salisbury were developing argon ion lasers for airborne measurement of water depth; the blue-green wavelength of the argon ion laser easily penetrates the water. During the development of the bathymetry system, researchers See, Garwoli and Len Hughes advanced large-current argon laser development by examining in detail the requirements for continuously flowing the gas, resulting in publication in April 1967 [15]. A few years later, WRE researchers Hughes, Macfarlane and Winokuroff developed water-cooled multi-electrode spiral flash tubes encased in diffuse reflector jackets filled with MnO_2 for more efficiently exciting Nd^{3+}-doped glass rods (Kodak Nd 11) for solid-state lasers operating in the region of 1 μm wavelength to be used as laser tracking devices leading to publication in 1969 [16]. Len Hughes whilst working at the WRE wrote an important paper [17] that suggested the

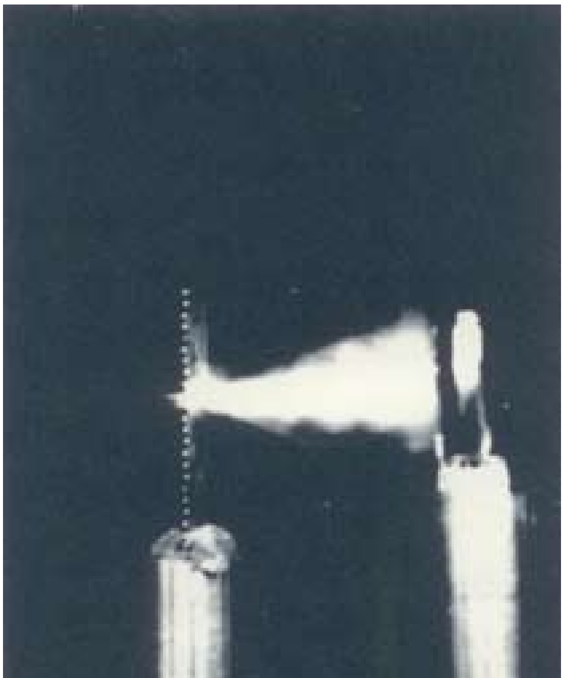

Figure 3. Experiments of focused ruby laser beams on a hacksaw blade during the development of a micro-welder to weld fine-wire thermocouples by Russell Whitcher when he was at DSL. The device would also later weld the protective stainless steel sheath around the thermocouple, all carried out under the microscope. Photograph from the Annual Report of the Defence Science Laboratories 1964-1965. Copy courtesy of Russell Whitcher.

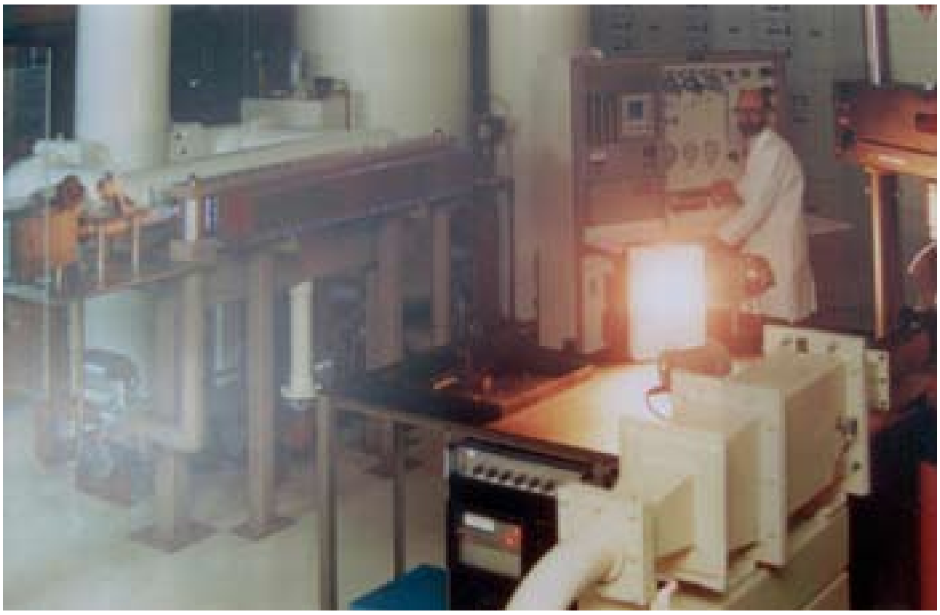

Figure 4. The output from a 60 kW CO_2 laser is focussed on an aerospace sample under load with wind flow. The photograph also shows Russell Whitcher when he was working at DSL. Photograph courtesy of Russell Whitcher.

use of semiconductor diodes as the most feasible pump source for Nd^{3+}-doped glass rods for the production of high energy Q-switched laser pulses suitable for "laser probes" in high energy physics.

Beginning in 1967 and lasting well into the 1970s, a large portion of the laser research within the defence community focussed on directed energy applications with the aim of creating high output power for applications requiring precisely controllable sources of heat. At the time, the most powerful laser known was the CO_2 laser, and Australian efforts on CO_2 laser research were initially carried out at DSL. Developments such as the use of fast gas flows (of up to 40 ms^{-1}) across the discharge space of the CO_2 laser tube that supplied new gas mixtures every millisecond were used to solve the lower laser level bottleneck problem. In addition, the use of the continuously supplied cooler gas reduced the tendency of the discharge to contract into an arc channel thereby delivering more power into the discharge volume. Research carried out in the late 1960s led to the world's first continuous wave CO_2 laser operating at atmospheric pressure [18] and to the first CO_2 laser that used plasma injection for a record 7 kW pulsed output power. Perhaps the culmination of Australia's first decade in laser research was the demonstration of 60 kW total output power from a single CO_2 laser oscillator (see Figure 4).

So by 1970 the stage was firmly established for Australia to significantly grow its world-leading research and development activities in laser physics and the application of lasers in science, defence and engineering. Whilst in the 1960s almost all the laser-based research was carried out by the defence community, the 1970s marked a new era in Australian laser-based research with universities beginning to dominate. Large and productive research groups were established at the Australian National University, the University of New England, the University of Sydney, the University of New South Wales, Macquarie University, La Trobe University and Monash University. Australian laser research and the application of lasers is now a mature field with a great history almost as long as the laser itself.

References

[1] G Troup, Masers, Methuen & Co., London, 1959.

[2] JR Singer, Masers, John Whiley and Sons Inc., 1959.

[3] GJ Troup, *"The optimum line width for the transition used in a reflection cavity maser amplifier"*, Australian J. Physics, **12**(3), 218 - 221, (1 September 1959).

[4] GJ Troup, *"The optimum line width for a reflection cavity maser"*, Australian J. Physics, **13**(3) 615 - 616, (September 1960).

[5] GJ Troup, *"Design of multimode waveguide cavities for solid state masers"*, Proceedings of the I.R.E. Australia, **23**, 166-171, (March 1962).

[6] G Troup, *Masers and Lasers: Molecular amplification and oscillation by stimulated emission*, Methuen & Co. Ltd (London) and John Wiley (New York), 1963.

[7] DR Skinner and J Tregellas-Williams, *"Total energy and energy distribution in a laser crystal due to optical pumping as calculated by the Monte Carlo method"* Australian J. Phys., **19**, 1, (1966).

[8] J Whittle, DR Skinner, *"Transfer efficiency formula for diffusely reflecting laser pumping cavitities"*, Appl. Opt., **5**(7), 1179-1182, (1966).

[9] WEK Gibbs, RE Whitcher, *"Polarization effects in roof-top ruby laser"*, Appl. Opt., **4**, 1034-1035, (August 1965).

[10] PWA Bowe, WEK Gibbs, J Tregellas-Williams, *"Lifetimes of saturable absorbers"*, Nature, **209** (5018), 65-66 (1966)

[11] WEK Gibbs, HA Kellock, *"New laser oscillation in chloro-aluminium phthalocyanine(CAP)"*, IEEE J. Quantum Electron., **3**(10), 419, (1967).

[12] WEK Gibbs, RE Whitcher, *"Time-resolved beam structure of an active Q-switched ruby laser"*, Appl. Opt., **6**(11), 1957-1959, (May 1967).

[13] JV Ramsay and K Tanaka, *"Construction of a single-mode D.C. operated He/Ne lasers"*, Japanese J. Appl. Phys., **5**(10), 918-923, (October 1966).

[14] WA Kricker, WIB Smith, "*A moving mirror laser interferometer for plasma diagnostics"*, Phys. Lett., **14**(2), 102-103, (January 1965).

[15] BA See, W. Garwoli, JL Hughes, *"Precautions required when using a continuous gas flow in a high-current ion lasers"*, IEEE J. Quantum Electron., **3,** 169-170, (April 1967).

[16] WAR Macfarlane, JL Hughes, A Winokuroff, *"Increasing the excitation efficiency of a rod laser"*, J. Scientific Instruments, **2,** 442-443, (1969).

[17] JL Hughes, *"The potential of present day lasers as scientific probes for investigating the structure of matter using an exponential amplifier"*, Appl. Opt., **6**(8), 1411-1415, (August 1967).

[18] R McLeary, WEK Gibbs, *"CW CO2-laser at atmospheric-pressure"*, IEEE J. Quantum Electron., **9**(8), 828-833, (1973).

Stuart Jackson is with MQ Photonics, Department of Engineering, Macquarie University.

Product News

Highest Power Supercontinuum Laser

Fianium now offers the WhiteLase™ SC400-20, the world's most powerful blue-enhanced supercontinuum laser with over 20W of total power. This new laser produces over 3W of visible (400-750nm) and 4W of extended visible (400-850nm) power and a continuous output spectrum from <400nm to 2400nm.

Like all Fianium Supercontinuum Lasers, the WL-SC-400-20 operates at MHz repetition rate making it ideal for steady-state or time-resolved measurements and a perfect alternative to multiple discrete CW or pulsed lasers. With the addition of a tunable filter, users can expect >50mW output power at 405nm, and even higher powers at any other visible wavelength.

The laser is fully integrated with touch-screen control, requires no user maintenance and is compatible with all WhiteLase tuneable filters and accessories.

New Ultrafast Laser Delivers Femtosecond Pulses at 40W Average Power

Coherent has released Monaco, a diode-pumped ultrafast laser delivering 40µJ pulses at 1035nm, with repetition rate variable from single shot to 1MHz. Standard pulsewidth is <400fs and an option is available for variable pulsewidth from <400fs to 10ps.

Monaco has outstanding beam quality ($M^2 < 1.2$) making it ideal for demanding micromachining applications in research and industrial environments. Homogenous materials such as glass and metals as well as complex layered structures are readily addressed with Monaco's sub-400fs pulsewidth.

Finally, Monaco's reliability is assured through the HALT (Highly Accelerated Life Test) and HASS (Highly Accelerated Stress Screen) protocols employed during development and throughout production. Commonly used in the consumer electronics and automotive industries, Coherent has introduced HALT/HASS to the laser industry to bring an unrivalled standard of reliability and quality to laser-based manufacturing.

New – Coherent Fidelity HP Ultrafast Fibre Oscillator <140fs Pulsewidth, up to 18W Average Power

The Fidelity HP is the latest addition in Coherent's Fidelity turn-key oscillator packages. The Fidelity HP is an ideal source for nonlinear microscopy applications including optogenetics and functional brain scanning, nonlinear optics, and commercial two photon polymerisation applications.

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- 10W or 18W average power
- 1040nm horizontally polarized output
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- Compact, turn key platform

As with the Monaco micromachining laser, and almost all next-generation Coherent advanced laser systems, reliability is assured through the HALT (Highly Accelerated Life Test) and HASS (Highly Accelerated Stress Screen) protocols employed during development and throughout production. Thanks to these integrated engineering principles Coherent provides new laser systems with both a lower cost- and time-to-data throughout its new product lines.

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The latest offering by FEMTO is the OE-300 Series variable gain photoreceiver, a high-speed photoreceiver with variable transimpedance gain from 10^2 to 10^8 V/A and bandwidth up to 200 MHz.

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- Laser intensity noise measurements (RIN)

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Key Features

- Integrated multi-lasers, spectrometer, touchscreen computer
- Standard wavelength options at 532, 785, and 1064 nm (custom wavelengths available)
- Dual wavelength options at 532/1064 and 785/1064 nm (custom wavelengths available)
- Various Quick-Change Sample options for any sample type
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Optics in Everyday Life: Producing Optical Surfaces

by Tony Klein

The active surfaces of optical components must be accurate to fractions of a wavelength, both in smoothness and in geometry. Smoothness is achieved by grinding with finer and finer grades of abrasive powders, such as carborundum grit (Silicon Carbide), corundum (powdered Aluminium Oxide) and Jewellers' Rouge (Cerium Oxide), all of which are harder than the glass or fused quartz to be ground and polished. Finally, there is the process of flame polishing whereby surface micro-protrusions are melted, filling in micro-depressions. But what about the geometry of the surfaces, which must be equally accurate? That is also achieved by grinding, by methods to be described below.

There is a maxim in the optical trade: If you can measure it, you can produce it. The measuring is, of course, done optically, by means of interferometry, often white light interferometry, but even better, with blue lasers. How is the grinding done, especially by hand?

Starting with two thick blocks of flat glass, (preferably of low expansion coefficient for thermal stability), one on top of the other, usually stuck to a backing block using pitch (bitumen), one uses a paste or suspension of abrasive powder. By rubbing the top block in a straight line, backwards and forwards, using finer and finer abrasive, the two surfaces end up in pretty perfect contact all over, and become two geometrically conforming surfaces. But are they flat?

Well, yes, locally, but not on a larger scale. In fact they end up as geometrically "conforming" surfaces, but with opposite radii of curvature: One concave (usually the bottom one) and the other one convex. The fact that the surfaces end up as conforming, over the full range of relative positions over which they were ground, means that the curvatures are constant, but with equal and opposite sign in the direction of the grinding motion, and zero curvature at right angles to it. (One has some control over the actual radius of curvature by pressing harder in the middle of the stroke).

The resulting objects are, in fact, cylindrical in shape and are useful for making cylindrical mirrors. They have their occasional uses in optics but not nearly as frequently as spherical mirrors. How does one produce those?

To obtain constant curvatures in all directions, i.e. spherical surfaces, it is obvious that the grinding with finer and finer grades of abrasive paste must be done in all directions, by gradually changing the angle of the grinding motion, making sure that an equal number of strokes are applied in each incremental change of the angle, several times over several cycles of going round and round the circumference of two superimposed blocks (assumed to be circular) as shown in Figure 1.

This is how amateur telescope mirrors used to be hand-made – a very tedious process, even for 100 mm diameter blanks and very much more so for 150, let alone 300 mm objectives – in the last case 27 times as much volume of material having to be ground away. The focal length of such mirrors depends on the actual shape of the resultant object, i.e. the depth of the concavity which, in turn, depends on how much relative pressure is applied in the middle of the grinding strokes. This important quantity, i.e. the precise shape, has to be verified in the coarse grinding step, before the finer grinding and polishing is carried out. The process has to be interrupted by frequent washing and interferometric checking and, as I said, it can all be extremely tedious.

Nevertheless, before affordable commercial telescopes for amateurs became available, many students and amateur astronomers of earlier generations ground their own telescope mirrors by standing and slowly walking around barrelheads while grinding away using finer and finer abrasives, ultimately Jeweller's Rouge. (However, a single left-over grain of coarser grit could gouge out groves, which required going back to an earlier stage!).

The resulting telescope mirrors (meaning the concave ones on the bottom of the two surfaces) required one last step to turn the spherical surface into a parabolic one, so that an object at infinity (e.g. a star) would produce a diffraction limited point image. This is a rather tricky empirical process described in the books about amateur telescopes [1]. Needless to say, automatic machinery is used in the mass production of much cheaper telescopes and more

Figure 1. Grinding a large telescope mirror. Image credit: Ante Perkovic under Creative Commons Attribution Share-Alike 3.0 Unported license https://creativecommons.org/licenses/by-sa/3.0/deed.en

Figure 2. "Perfect" sphere of Silicon produced by Achim Leistner at CSIRO in Sydney. In the foreground is a version of the apparatus for grinding optically precise spheres. Image credit: CSIRO.

complicated mechanisms are used in the production of large mirrors whereby the complex motion of the upper surfaces ensures the random coverage of the blank as the grinding proceeds, thus ensuring a constant curvature [2].

Spherical lenses, i.e. lenses with convex or concave surfaces can be produced by employing the same principles, as was the way the age-old tradesmen, namely the lens grinders did it. Some of them became quite famous for discovering compound lenses to correct aberrations. These consisted of doublets, triplets and achromats made out of different types of glass, such as crowns and flints. Eventually a complex industry with highly advanced machinery took over and more complicated surfaces, such as the now common aspherics became possible. (The very high sensitivity of silicon-based sensor elements made it possible to use lenses of much smaller diameter, which are much easier to produce – leading to much more affordable cameras of superb optical quality becoming available – but that's another story) [3].

Optically flat surfaces – the special case of zero curvature - present another challenge. It is not immediately obvious how these can be made using the same process as described above. It turns out to be very straightforward – at least in principle: One begins with *three*, rather than two identical blanks, let's call them A, B and C. Then one begins grinding A against B, in all directions and then swapping C for B and then C against A and grinding them in all directions and so forth, *in pairs*. A moment's thought will convince you that if all the pairs of surfaces conform to each other, then each of them will have a surface of *zero* curvature and the result is *three* optical flats, useful for producing test plates, such as mirrors for interferometers etc. In the same way test gauges made of hardened steel can be manufactured, giving accurate dimensions with optically flat surfaces.

One final example that makes use of a related geometrical principle: How does one make optically "perfect" spheres? Not just with the surface accuracy but also the shape, i.e. equal diameters in all directions? And not just in glass, but in marble, granite, silicon etc? There are several variant processes, requiring two or more identical hardened cup-shaped tools, in the end of each of which a V-shaped conical depression is produced (in a way that is left as an exercise for the reader), so that the angle of the V in each tool is precisely 60°. The tools are held at variable angles above the first one and then a roughly spherical blank (of glass or stone) is introduced in the space between the cups, together with some abrasive paste. The tools with the conical depressions are rotated, and the blank will tumble in all directions.

Eventually the blank acquires a constant curvature thus turning into a sphere (at the same time the angles of the conical depressions inside the tools will slowly turn into precisely 60°). Since only steady rotations are required, it can all be done by a machine, so that no manual effort is required beyond frequent washing and changing of the abrasive.

One of the most precise versions of such an apparatus is shown in the foreground of Figure 2, in the process grinding a "perfect" sphere of isotopically pure Silicon by Achim Leistner in the CSIRO laboratories at Lindfield, in Sydney. The resulting object is to be used for a precise definition of the Standard Kilogram in terms of atomic constants, such as Avogadro's number and the lattice spacing of silicon crystals [4]. The silicon sphere shown in the photograph is said to be the most perfect sphere anywhere in the universe!

Using this process on a larger scale, marble spheres for ornamental use can be manufactured, as can glass or "crystal" balls. Such spheres made out of glass with a refractive index of 1.5 are at the heart of a very common meteorological instrument, namely the "sunshine recorder" named after Campbell and Stokes who invented and perfected it (see Figure 3). When exposed in the open air, the glass sphere produces a focused image of the sun (when it is shining) on the back of the glass sphere where it burns a trace on a paper backing. This 'burning glass" image moves with the apparent motion of the sun, resulting in a trace of which the total length indicates the hours of sunshine in a day.

Of course crystal balls for use by fortunetellers need much less precision!

References

[1] Albert G. Ingalls (ed.), *Amateur Telescope Making* (Vols. 1–3). Orig. edition: Scientific American; new rearranged edition: Willmann-Bell Inc.

[2] Lois Bell, *The Telescope*, Dover Publications, New York, 1981

[3] W. Zschommler, *Precision Optical Glassworking*, SPIE/Macmillan

[4] https://en.wikipedia.org/wiki/Kilogram

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

Figure 3. Campbell and Stokes Sunshine Recorder. Image credit: Bidgee under Creative Commons Attribution 3.0 Unported licence. https://creativecommons.org/licenses/by/3.0/deed.en

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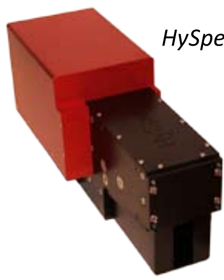


Science Talent Search 2015 - "Science of Light"

by Stephen Collins

The Science Talent Search (STS) is an annual, science based competition open to all primary and secondary students in Victoria. This year the theme was "Science of Light".

The Science Talent Search (STS) was founded in 1952, making it one of the longest running programs of its type in the world! It is managed each year by the Science Teachers' Association of Victoria Inc (STAV), established for the purpose of promoting science and science education. In recognition of IYL 2015 this year's theme was "Science of Light", and on Monday 23 November 2015 the winning entries were on display at La Trobe University, Bundoora campus (Melbourne) and prizes were awarded. Multiple lecture theatres were required so that the numerous prizes could be presented in the limited time available; all prizes had been provided through sponsorship.

Students could submit entries relating to this theme in categories of Science Photography, Video Productions or Games or in the following areas with specific topics mentioned:

Picture Story Books (Creative Writing) - (Primary Divisions) using one of the following:

- When the lights went out
- Now you see me, now you don't...
- Glow! Flash!
- Light is life

Creative Writing – based on:

- Light saved it
- Forever light
- Glow
- From light to illusion

Posters - Scientific Wallcharts (Primary Divisions) using one of the following:

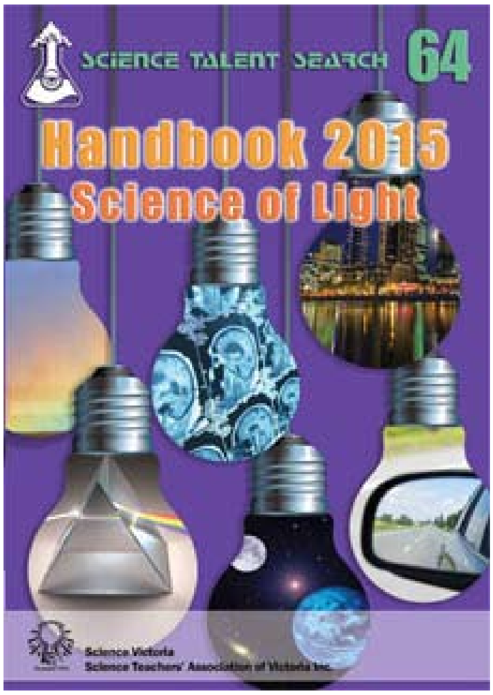
- Life needs light
- Light at the bottom of the ocean
- Illusions
- Mixing light

Posters - Scientific Wallcharts using one of the following:

- Making waves, the science of light
- Life without light
- Animal perceptions of light
- Applications of light

Over 2000 entries were received and judged, and clearly an enormous amount of effort went into the competition on the part of students and teachers. There is not space here to capture the scope of the work submitted by the students. Those interested should refer to the website http://www.sciencevictoria.com.au/sts

Science Photography displays. Image courtesy of STAV Science Talent Search.



Science Talent Search handbook cover.

The Coordinator for Posters-Scientific Wallcharts – Junior and Intermediate Divisions summarised the entries:

The favourite topic for entrants was "Animal perceptions of Light" at 42%. Next popular was "Life without Light" at 27%, then "Making waves, the Science of Light" at 18%. Least favourite was "Applications of Light" at 13%. Posters based on "Animal perceptions of Light" covered the following animals: dogs, cats, humans, snakes, sea mammals, monkeys, bulls, sea turtles, deer, horses, bees, fish, mantis shrimp, sharks, owls, chickens and eagles. They included data on monochromats, dichromats, trichromats and tetrachromats, plus the structure and phototaxis associated with worms and moths. Posters based on "Life without Light" covered some of the following concepts: Chemosynthesis and hydrothermal vents, bioluminescence and deep sea creatures and fireflies, the Mariana trench, photosynthesis, food chains, vitamin D, animal kingdoms, prokaryotic organism's cells, sources of light, light penetration of sea water and echolocation.

Posters based on "Making waves, the science of light" included data on Emission spectra, rainbows, waves and wavelength, speed of light, excited electrons, dispersion, refraction and reflection.

Posters based on "Applications of light" included data on optical fibres, lasers, *solar panels, shadows, fireworks, food preparation, light sabers, glow in the dark items, astronomy and spectroscopy.*

It was fantastic to see a great excitement amongst the students present, particularly with those who were able to have a demonstration on some aspect of light. Two of the demonstrations are pictured here: a refraction demonstrator and a rudimentary light globe in which a pencil lead glows in a glass jar when subjected to electrical current from a battery.

A real highlight for me was the obvious partnership between students and their teachers, in seeking to deepen scientific knowledge and also in communicating this to a wider audience. Although the AOS was not involved directly, certain of the aims of IYL2015 within Australia, relating to promoting the role of light to younger generations were clearly realised through the 2015 Science Talent Search.

Stephen Collins is with Victoria University.

Science Photography displays. Image courtesy of STAV Science Talent Search.

Student demnstration of a simple light globe using a pencil lead and battery inside a glass jar. Image credit Stephen Collins.

Refraction demonstration display. Image credit Stephen Collins.

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Growing Tall Poppies: Real Science with Real Scientists

by Nicholas Anthony and Hannah Coughlan

How can we increase the overall level of science and mathematics literacy in Australia? The Growing Tall Poppies program may be part of a solution to this issue that has been recently recognised by the Chief Scientist of Australia, Professor Ian Chubb.

Figure 2. 3D printed models of the Cochlea bone printed by students from Catholic Regional College Melton at La Trobe University in September as part of the Growing Tall Poppies program.

Growing Tall Poppies is a scientific partnership program providing a curriculum based model of learning for secondary school students based on authentic science experiences with real scientists. The program aims to highlight science as a human endeavour, science inquiry and investigation, science communication, and career pathways and opportunities to secondary school students. Growing Tall Poppies allows high school students to interact with real scientists in the form of researchers, PhD and honours students, and lecturers in research environments. The express aim of Growing Tall Poppies is to increase the number of females studying the physical sciences in years 11 and 12 to narrow the gender gap in Science, Technology, Engineering and Mathematics (STEM) subjects.

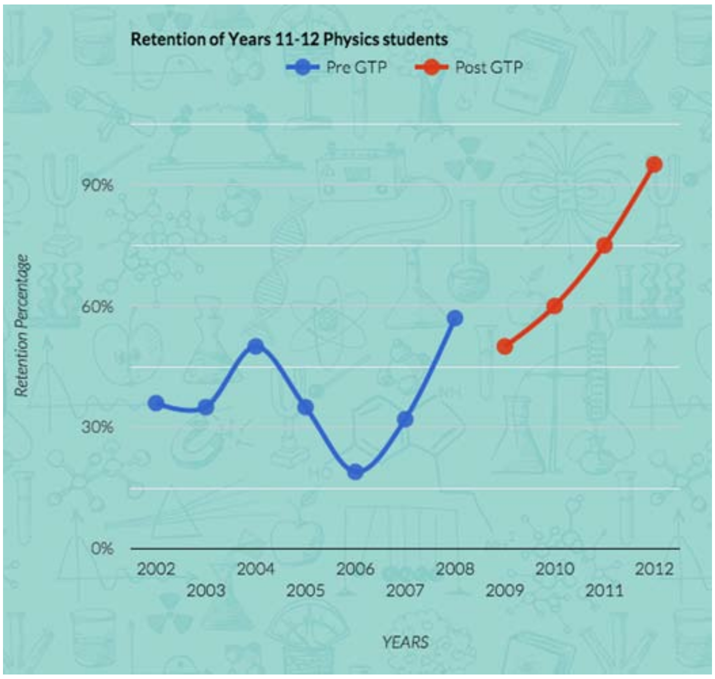

Figure 1. Percentage of students at Santa Maria College choosing to continue to study physics at years 11 and 12. Growing Tall Poppies started in 2008, after which there is an increase in the retention rate.

Growing Tall Poppies started in 2008 as a partnership between the University of Melbourne, the ARC Centre of Excellence for Coherent X-Ray Science (CXS), and Santa-Maria College. The program was designed around the shared goal of providing positive and engaging experiences for students to enhance their learning of science by interacting with the scientific community. By providing authentic experiences with scientists in a research environment, the program aims to connect students to real researchers with world changing goals from their research. This objective of Growing Tall Poppies is reflected in the naming of the program as it emphasises the potential that students, given the opportunity, have to rise above the norm in achievement. Their potential to become 'Tall-Poppies' in the scientific landscape.

The Director of Growing Tall Poppies, Dr Eroia Barone-Nugent, started the program when, as a teacher, she saw more and more girls drop studying physics as they could not see how it was relevant to their interests. It's her hope that students walk away learning four things; you are capable of doing science; there are careers in science; scientists are real people from all different backgrounds; and science can change people's lives.

Since Growing Tall Poppies' beginnings in 2008, the program has seen incredible growth in the number of participants and the amount of partner institutions. 2015 sees the program expanded outside of Victoria to Queensland and now encompasses 33 schools, 13 partner organisations, and over 2,000 direct participants. Partners include: The University of Melbourne, La Trobe University, Griffith University, University of New South Wales, Deakin University, Australian Synchrotron, ANSTO, Catholic Education Office Melbourne, ARC Centre of Excellence in Advanced Molecular Imaging, ARC Centre of Excellence for Mathematical and Statistical Frontiers, Santa Maria College and Charles La Trobe Secondary College.

The aim of Growing Tall Poppies is being realised, with a study of the retention rate of students at Santa-Maria College studying physics from year 11 to year 12 increasing to well over 80% (see figure 1). However this is just the start of the Growing Tall Poppies effect. As the program matures and spreads it's hoped that these numbers, this real growth in physics retention, is experienced on a state and national scale. After the initial trial of the program at Santa Maria College, the Growing Tall Poppies program was funded for three years at the beginning of this year by the federal government's Australian Maths and Science Partnerships Programme (AMSPP) to expand.

Figure 3. Students from Academy of Mary Immaculate with an Atomic Force Microscope at La Trobe University as part of the 'Hairy Science of AFM' project.

La Trobe University is one of the partner institutions of Growing Tall Poppies with four different programs available to secondary school students. By the end of this year La Trobe will have had over 50 students go through a Growing Tall Poppies program on site.

The programs are designed to have different scientists take sessions to discuss scientific concepts, their experiences and the different job pathways available to scientists. These take the form of a mentor, typically a PhD student, who coordinates the program as a whole and offers advice and support to the students. The key to the success of the Growing Tall Poppies programs is the people involved, who aim to produce a genuine, relatable, and hands on science based experience for the students involved.

La Trobe University boasts an increasing collection of Growing Tall Poppies programs run once per school term across the year. The stars of La Trobe's Collection are its 'Hairy Science of Atomic Force Microscopy' and 'Medical Science of the Cochlea Implant' programs which have been run since 2014 with different school groups. This December La Trobe is increasing its efforts and introduced 'Astronomy, Miniaturisation, and the Impact on Medicine' and 'Synchrotron Science and Protein Crystallography' to its collection.

The 'Hairy Science of Atomic Force Microscopy' explores different length scales and the various methods we can use to investigate the sample; in this case the sample of interest is human hair. Showcasing just one of the many ways that physics plays a role in crime scene analysis, species identification, and investigating tiny structures in biology. The students take part in using real research equipment to look at different hairs to see what kind of information they can gather using laser diffraction and atomic force microscopy (AFM). AFM is a state of the art research technique which uses a tiny, sharp-tipped probe to measure height and sample roughness at the nanometre scale and is also capable of measuring friction, magnetism and conductivity. Students also get a chance to perform lithography on a hair using the AFM.

Another program conducted at La Trobe is the "Medical Physics of the Cochlea Ear Implant". This program gives students a hands on view of the interdisciplinary nature of science through a look at the development of the cochlea implant, a marvel of the interaction between physics and medical research. The students work with researchers at La Trobe University to learn about and use X-ray tomography to image an object in 3D with an emphasis on medical imaging. Students also get to explore 3D printing through the printing of their own 3D cochlear bone model. The model along with the medical imaging connects how engineers, surgeons and researchers have allowed the deaf to hear with a cochlear implant.

The third program involves looking at the way in which we travel to space and the key role that robotics plays. Students are put in charge of LEGO Mindstorms kits and given briefs to build robots to interact with objects, in a similar fashion to the Mars rover. Students are shown some of the technological and medical advancements that have taken place through space research, and have fun making and controlling their robots whilst doing so.

Students are given access to one of Australia's premier science facilities, The Australian Synchrotron, as part of the final project, to learn how it is that scientists of all disciplines use the brilliant light to understand our world at the smallest of scales. Again the secondary school students are connected to real world scientists who use instruments such as the Australian Synchrotron as part of their research as they go through each step of the process of protein crystallisation, data collection and analysis of their own protein sample.

In addition to the important scientific

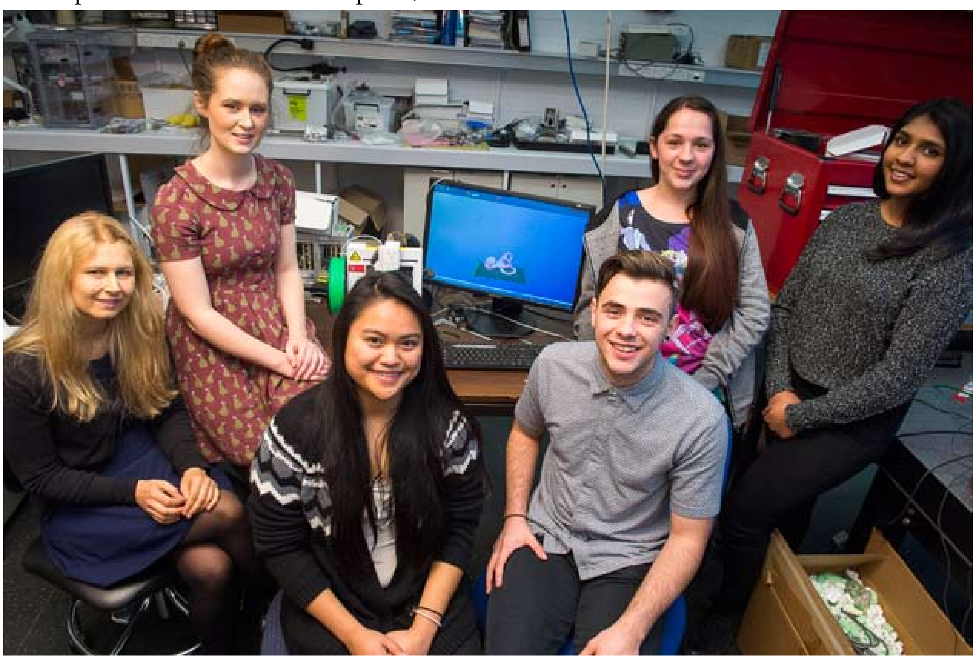

Figure 4. Growing Tall Poppies students from Catholic Regional College Melton with the 3D printer and project mentors Yvonne and Hannah at La Trobe University.

methods that students are exposed to by Growing Tall Poppies, one of the key aspects that sets it aside from other outreach programs is the interactions that the high school students get with 'real scientists'. These scientists range from honours and PhD students to lecturers and professors where the scientists are encouraged to share their experiences and journeys in science. It's these interactions that really leave an imprint on the students and help them overcome misconceptions that they may have about science and who studies or performs it. A lot of the students assume that science, and particularly physics, is just done by old men in lab coats. It's always interesting to watch them realise that anyone can be a physicist and anyone can do research regardless of gender or background. The program also emphases to students that STEM can be a part of many different careers and can benefit someone who isn't necessarily a researcher. Students see the importance of the science and that interaction is vital. But it's also great to be able to talk to them about finishing high school, what university is like, and anything else they may want to ask. The scientists that take the students are called mentors for a very valid reason. They mentor the students.

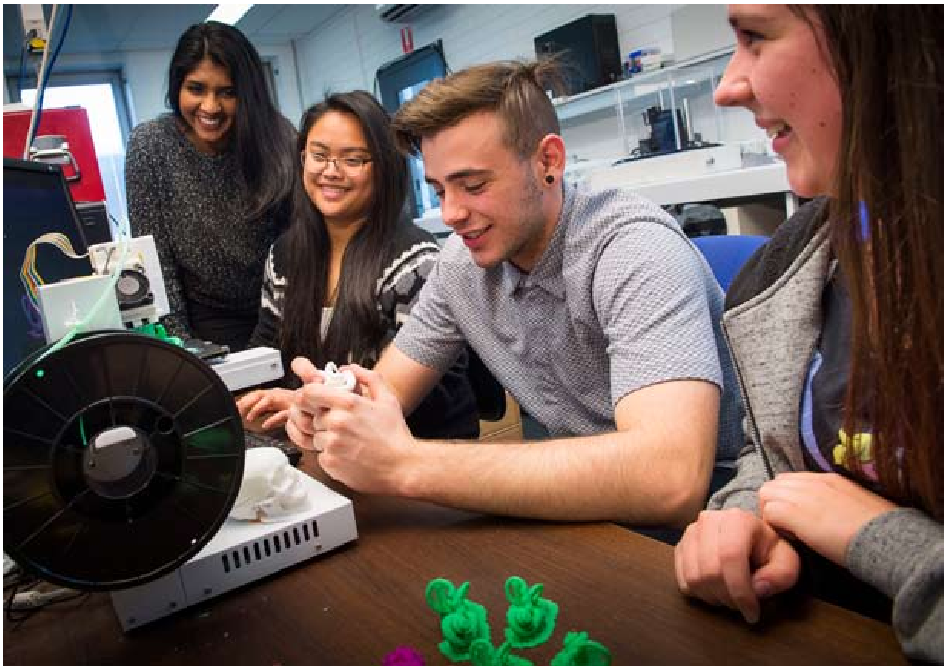

Figure 5. Students from Catholic Regional College Melton with the 3D printer and models at La Trobe University as part of the Cochlear implant project.

For the mentors and researchers involved, Growing Tall Poppies also provides a fantastic avenue for meaningful professional development. The communication skills and interactions with the next wave of potential scientists are irreplaceable.

Growing Tall Poppies is expanding at an enormous rate. In the years to come it is hoped that the programs will continue to help influence new waves of students to see science, and indeed physics, as an important part of education in modern Australia.

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Nicholas Anthony and Hannah Coughlan are with the Department of Chemistry and Physics, La Trobe University, Melbourne.

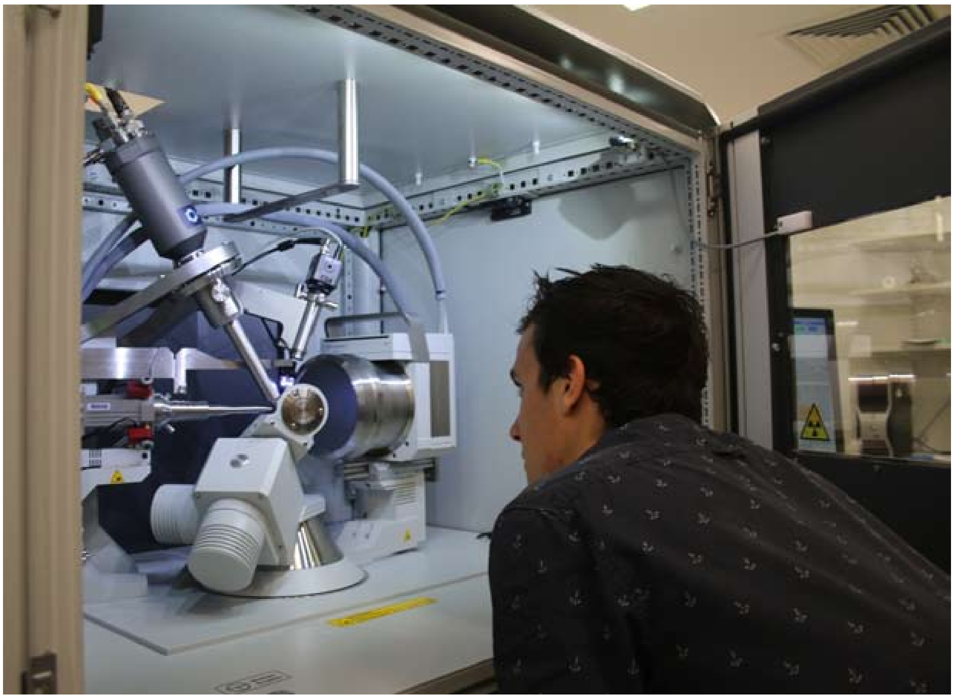

Figure 6. Student from Sacred Heart College Kyneton with the x-ray generator at La Trobe University, about to collect diffraction data from lysozyme crystals as part of the Synchrotron Science project.

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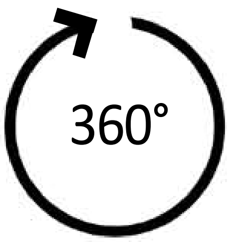
'Spectral Products' is an industry leader in the design and manufacture of optical instruments including spectrometers, monochromators, spectrographs, spectrophotometers, spectrum analysers, detection systems, light sources as well as fiber optic cables and couplers. Spectral Products introduced the first total microprocessor-controlled, direct drive scanning monochromator in 1987. The award-winning design eliminated the commonly used, but costly and unreliable, sine-bar drive for wavelength control. Today, the Spectral Products' Digikröm line of monochromators combines microelectronics with precision optics while featuring computer control, direct digital drive, automatic grating changes and motorized slits. This careful marriage of microcomputers with precision opto-mechanics is an example of why Spectral Products are now the world leader in low-cost high performance spectroscopic systems.

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



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Fibre Optic & Photonic products

Optical Fibre Path Delay Line

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 lengths to suit your application. Suitable for optical network testing and analysis, fibre laser and time delay applications.

- Insertion loss 03 ~ 0.5dB per km
- Customised fibre length: 50m, 100m, 200m, 1km ~ 5km
- Operating wavelength range: 1260 ~ 1650nm standard
- Fibre type: G.652.D SMF

Polarization Maintaining Patch Cords/Jumper Leads

PM jumper leads are built with PM panda fibre and connect using FC, SC or E2000 connectors. PM jumpers are also available unaligned and with a 360 degree tunable ferrule for laboratory use.

- High extinction ratio over 25dB
- Wavelength range: 980nm, 1064nm, 1310nm and 1550nm
- Low insertion loss <0.4dB and return loss over 55dB
- Narrow key or wide key connectors for FC type

Polarization Beam Splitter/Combiner

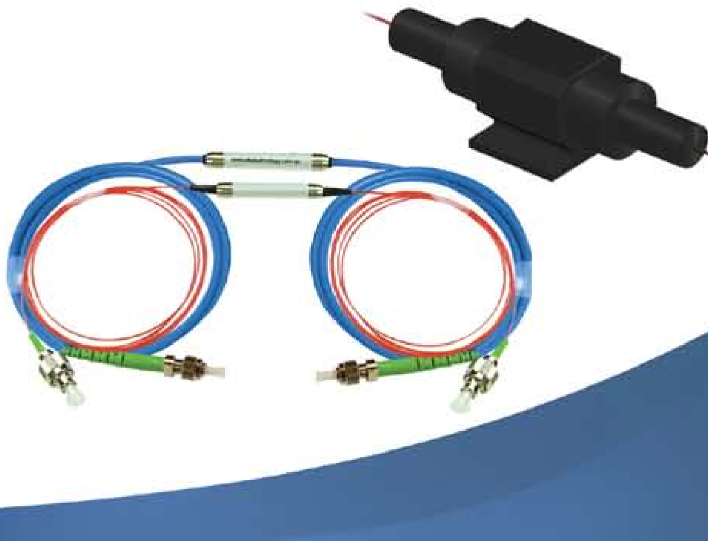
The device can combine two orthogonal polarization to one output fibre or split incoming light into two orthogonal states.

- Singlemode fibre or PM panda fibre
- High extinction ratio ER>25dB, low loss
- 980, 1030, 1064, 1310 or 1550nm wavelengths
- Supplied with FC or FC/APC connectors, narrow or wide key

Fibre Optical Isolators

Complete line of fibre coupled isolators for wavelengths ranging from 980nm to 1625nm. Available in two versions: polarization insensitive and polarization maintaining.

- Wavelength range: 980, 1030, 1064, 1310, 1480 or 1550nm
- Fibre type: PM panda, SMF28 or Hi1060
- PM isolator with or without polarizer
- High isolation and high extinction ratio
- Slow axis of fibre aligned to the connector key
- FC or FC/APC connectors, narrow key or wide key
- 300mW, 1W, 3W or 10W CW power handling



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