MACQUARIE UNIVERSITY | MQ PHOTONICS RESEARCH CENTRE

NEWSLETTER

Issue 60 – 3rd June 2014

MQ Photonics Newsletter is an informal internal publication of the ***MQ Photonics Research Centre*** <http://web.science.mq.edu.au/groups/mqphotonics/>.
We aim to distribute it by e-mail every 3 weeks. Please send copy to <Elizabeth.Bignucolo@mq.edu.au> by 9 a.m. on the due date. **Next due date: to be advised**

Focal Points

MQ Photonics members have featured prominently in the media and professional society commentaries since the last newsletter. Those stories, based on new breakthroughs in diamond and quantum photonics (ironically published as two different papers in the same issue of Laser and Photonics Reviews), were triggered by media releases developed by our researchers and the university's media office. I trust our recent seminar by freelance science journalist Leigh Dayton will also encouraged more members to promote their work through the public media.

You can find out more about the media take-up of these stories on the MQ Photonics website (thanks to Rich) and in the body of this newsletter.

Hearty congratulations to Doug Little for winning the prestigious NMI metrology prize. We hope to have a MQ Photonics contingent cheering him on when he receives his award in the next few weeks."

Mick Withford

Australian Government
National Measurement Institute

NMI Awards 2014 Winner – Dr Douglas Little

Spinning the medical webs of the future

http://minister.innovation.gov.au/ministers/baldwin/media-releases/spinning-medical-webs-future

Dr Douglas Little, has been awarded the 2014 National Measurement Institute (NMI) Prize for ground-breaking measurement techniques developed to assess the potential of spider webs to be used for in vivo (in body) medical devices.

Announcing the award, Parliamentary Secretary for Industry, Bob Baldwin, said Dr Little's efforts to measure very accurately the refractive index of spider silks resulted in a 20 fold improvement on previous work. …

A new spin for spider webs

http://mq.edu.au/thisweek/2014/06/02/a-new-spin-for-spider-webs/#.U40DlSjztM8

"We have developed ways of measuring refractive index that are a 20-fold improvement on previous methods. This is significant, because we now have sufficient precision to measure how the refractive index of spider silks responds to environmental conditions such as temperature, humidity, strain or pH," said Douglas.

"This is exciting, as it opens up the prospect of using spider silks in a diverse range of technological applications."

Spider silks for example, could be used as mechanically-robust, miniature optical fibres to connect integrated optics and electronics; or as chemical, biological and medical sensors.

Spider silks seem especially suitable for bio-medical applications because their protein composition makes them especially compatible with biological systems.

There are also prospects to further enhance the properties of spider silks by incorporating nanoparticles into the protein structure, or through genetic modification. Importantly too, spider silks can be produced efficiently and sustainably.

"In the future, we may very well be farming optical materials from spiders and other insects, rather than producing them in factories," said Douglas.

Congratulations!

MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION

A/Prof **Andrei Zvyagin** has a grant from the Ministry of Education and Science of the Russian Federation entitled "Biocompatible photoluminescent nanocomplexes for Theranostics" (~A$ 2.9 M , 2014-2016), to establish a new research centre "Laboratory of Optical Theranostics" at the Nizhny Novgorod State University, Russia. Andrei will lead the new Centre from Macquarie.

Andrei has a second major grant from the Russian Federation, co-funded by industry (totallling ~A$ 2.9 M, 2014-2016). "Development of the nanotechnology-derived pharmaceutical solution based on the protein toxin and beta-emitter for the concomitant therapy of cancer" addresses new methods of oncotherapy, using radioactive photoluminescent nanoparticles.

Judith Dawes

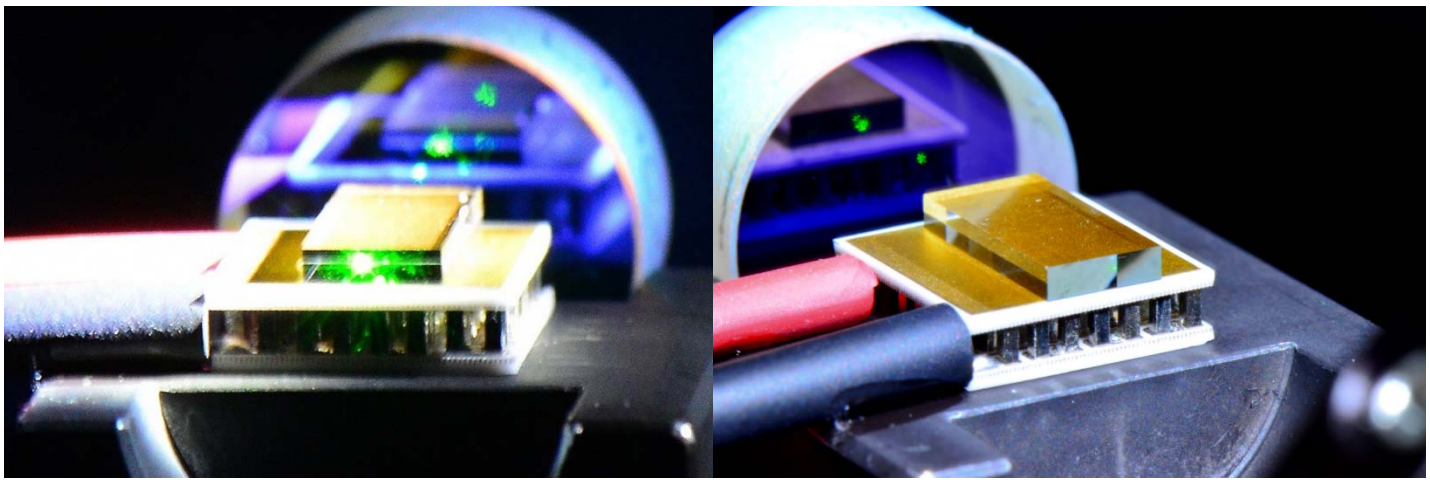
MACQUARIE UNIVERSITY
SYDNEY ~ AUSTRALIA

Congratulations to **Dayong Jin** for his promotion to Level D (Associate Professor).

Australian Nanotechnology Network

Congratulations also to **Chris Baldwin** for winning the 1st round of the ANN 2014 Overseas Travel fellowships.

MQ Photonics - Image of the month (May)



Up close with a diamond laser beam converter. This photograph shows a 1-mm thick synthetic diamond within a Raman laser resonator.

Contributors: Aaron McKay, Ondrej Kitzler, Rich Mildren

Photographer: Michael Haylen (image on left), Aaron McKay (image of right)

Conferences

2014 OSA Optics & Photonics Congress

Call for Papers

The OSA Light, Energy and the Environment Optics Congress

2–5 December 2014 | Canberra, Australia
Energy Change Institute, Australian National University

www.osa.org/EnergyOPC

IMPORTANT DATES:

Abstract and Summary Submission Deadline:
3 September 2014
12:00 EDT (16:00 GMT)

Advance Registration Deadline:
4 November 2014

If you have questions, please email cstech@osa.org or call +1 202.416.1907 *(outside the US)* or +1 800.766.4672 *(US/Canada)*

OSA

Host Organization:

Australian National University
ENERGY CHANGE INSTITUTE

This comprehensive Congress examines frontiers in the development of optical technologies for energy production, transmission and use. It also examines the use of optical and photonic approaches to monitor both energy usage and the effect of energy production on the environment. It is designed to bring together researchers, engineers and managers to foster timely information exchange between the disciplines involved in these fields.

PLENARY SPEAKER:
Steven Chu, *Stanford University, USA*

KEYNOTE SPEAKERS:
James G. Anderson, *Harvard University, USA* (E2)
Martin Green, *Australian Centre for Advanced Photovoltaics, University of New South Wales, Australia* (PV)
Toshihiko Iwasaki, *Konica Minolta, Japan* (SOLED)
Roland Winston, *University of California Merced, USA* (SOLAR)

OPTICS AND PHOTONICS FOR ENERGY AND THE ENVIRONMENT (E2)
E2 focuses on monitoring and controlling the generation of energy and its impact on the environment. The conference will showcase optical techniques and instrumentation used in monitoring, sensing and transmitting information relating to energy and the environment. It will bring together people from industry, university and government to address environmental impacts of energy production and policies to guide its management. Special emphasis will be on sensor devices for energy, environment and pollution monitoring, energy usage and transmission (including smart grid technology) and energy efficiency in industry.

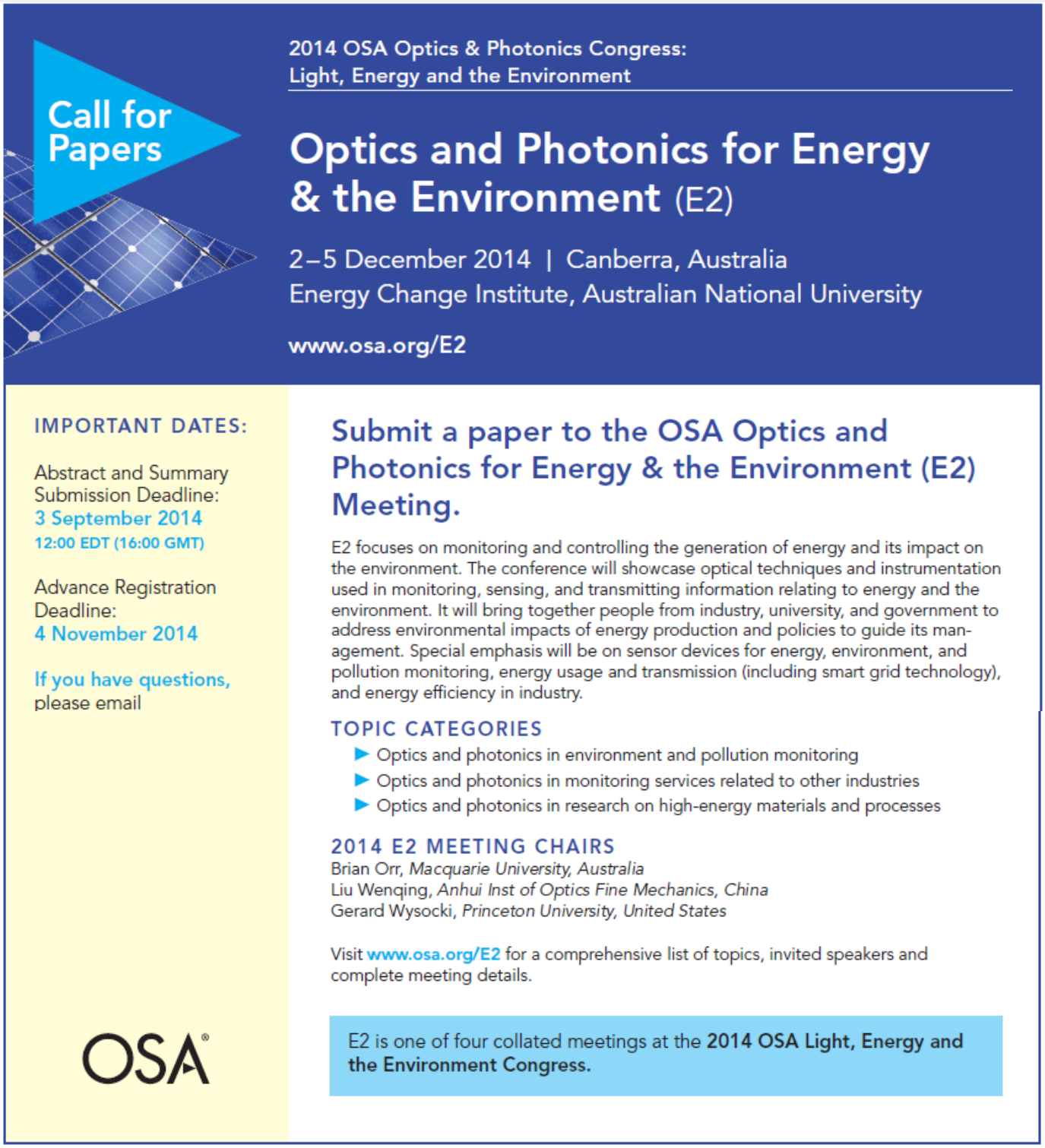
OPTICAL NANOSTRUCTURES AND ADVANCED MATERIALS FOR PHOTOVOLTAICS (PV)
PV brings together experts in nanophotonics, materials science and photovoltaics to discuss the latest developments in nanophotonic enhancement and nanostructured materials for the next generation of solar cells. Nanostructured materials and photonic enhancement schemes offer unprecedented opportunities to control both the optical and electrical properties of next-generation solar cells. This meeting covers all aspects of optical nanostructures for photovoltaic applications, from surface textures and diffraction gratings through to emerging topics such as plasmonic enhancement, nanowires, quantum dots, novel materials and spectral flux management in multi-junction solar cells.

OPTICS FOR SOLAR ENERGY (SOLAR)
SOLAR focuses on optics for solar energy applications including design, modeling, integration of novel materials, manufacture, field-testing and deployment, and economics. All forms of solar energy generation, transmission and storage – from thermal to photovoltaic to novel methods – will be covered. The program will highlight presentations spanning technology, public policy and finance.

SOLID STATE AND ORGANIC LIGHTING (SOLED)
SOLED focuses on new materials (both organic and inorganic) and new devices for lighting, their manufacture and lighting policy. The conference will showcase the latest inorganic and organic materials developed for solid-state lighting, novel lighting structures, theory and modelling, and manufacturing and lighting issues. It aims to bring together people from along the research, development and manufacturing pipeline with presentations from industry and academia.

Of the four collocated Conferences within the 2014 OSA LEE Congress, many of us in *MQ Photonics* are likely to find that on "Optics and Photonics for Energy and the Environment (E2)" particularly relevant.

Brian Orr



How time flies! Please note that the deadline for submission of abstracts to the highly recommended 2014 AIP Congress (incorporating the 2014 AOS Conference) is not far away (but not as close as it once was!) …

Brian Orr

Downloaded from <http://aip2014.org.au/abstracts/?IntCatId=60>

home
speakers
call for abstracts

the art of physics
latest announcements
program
social program
sponsorship & exhibition
registration
accommodation
general information
organising committee
contact us

quick links
- Register Online

TELL A COLLEAGUE BOOKMARK THIS SITE

Call for Abstracts

Submit Abstract Speaker Zone

Closes 5.00pm EST Friday 27 June.

The Australian Institute of Physics, in association with the Australian Optical Society, invites you to submit an abstract to the 21st biennial Australian Institute of Physics Congress, which will be held at the Australian National University in Canberra in the week December 7-11 in 2014.

The Congress aims to provide an opportunity to draw together all disciplines in which physics plays a central role, including fundamental research, applications and education. Along with a diverse array of exceptional invited speakers, it is a chance to experience the scope of the entire Australian physics enterprise, while still having plenty of time to focus on your specific discipline area. This celebration of "The Art of Physics" is also an opportunity for you to use your imagination in promoting your own research to the wider community.

The topic areas to be covered in the Congress include:

- The Art of Physics
- Atomic and molecular physics
- Condensed matter and materials
- Nuclear and particle physics
- Physics education
- Quantum information, concepts and coherence
- Biophysics and medical physics
- Solar terrestrial and space physics
- Theoretical physics
- Women in physics
- Optics, photonics and laser physics
- Plasma physics
- Geophysics
- Astronomy
- Acoustics and music
- Relativity and Gravitation
- Synchrotron science
- Complex systems, computational and mathematical physics
- Industrial physics and applications

We encourage all contributors to use the Congress theme: "The Art of Physics" to embolden the presentation of their work and communicate the inspiration behind their research.

For a list of confirmed speakers, please click here.

Publications

Recently published book chapter

Brian J. Orr and **Yabai He**, "Cavity-based absorption spectroscopy techniques," **Chapter 6 in "Laser spectroscopy for sensing: fundamentals, techniques and applications"** (ed. Matthieu Baudelet; Woodhead Publishing Ltd, UK; 2014) … ISBN 978-0-85709-273-1, *pp. 167–207, 293 references*

Abstract: Optical absorption spectroscopy enables atoms, molecules and media to be characterised in the chemical, physical, biological and earth sciences. It yields dependable and highly sensitive means of qualitative and quantitative analysis in many contexts: laboratory, environmental, industrial, clinical and beyond. 'Cavity-based' variants of absorption spectroscopy employ an optical cavity (usually resonant with one or more of the wavelengths of radiation used to observe absorption) to enhance the sensitivity (and, necessarily, the signal-to-noise ratio) by orders of magnitude relative to absorption spectroscopy performed without such a cavity. We offer general technical insights into various forms of cavity-based absorption spectroscopy, including: high-performance benchmarks such as NICE-OHMS; cavity-ringdown spectroscopy; cavity-enhanced absorption spectroscopy; intracavity laser absorption spectroscopy. We outline selected applications and indicate areas of current scientific interest and opportunity in this rapidly expanding field.

Laser Spectroscopy for Sensing, 1st Edition

Fundamentals, Techniques and Applications

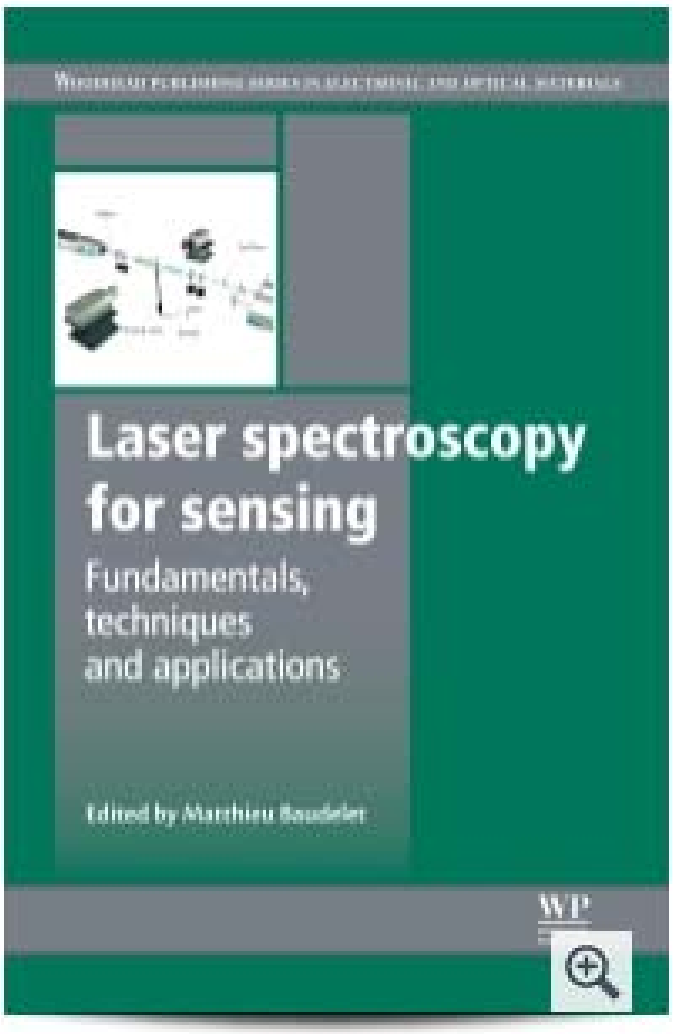


Table of contents

Editor : M Baudelet
Imprint: Woodhead Publishing
Print Book ISBN : 9780857092731
Pages: 592

From the fundamentals through techniques and sensing applications, this is the definitive guide to laser spectroscopy for a broad range of scientists and engineers

Recently published articles

Congratulations to Michael Steel on his article in Nature Photonics.

Well done Mike, keep it coming ……

nature photonics

news & views

NATURE PHOTONICS | VOL 8 | APRIL 2014 | www.nature.com/naturephotonics

Nature Photonics 8, 273–275 (2014) doi:10.1038/nphoton.2014.61

QUANTUM PLASMONICS

Two-plasmon interference

A new experiment demonstrates the first unequivocally quantum two-particle interference with surface plasmons. Subwavelength optical quantum information processing may be just around the corner.

Michael Steel

Even casual readers of *Nature Photonics* will have observed that plasmonics and integrated quantum photonics are two of the most active and rapidly developing fields in optics, being regularly featured in these pages. Although the general field of quantum plasmonics is also very active (for example, see Tame *et al.*[1] for a recent review), the particular field of the quantum behaviour of integrated surface plasmons is only beginning to take off.

In this issue, James Fakonas and colleagues from the Kavli Nanoscience Institute and the T. J. Watson Laboratory at Caltech in California, USA, report the first observation of two-plasmon interference that is unambiguously in the quantum regime[2].

A surface-plasmon platform for quantum optics offers the potential to realize subwavelength quantum devices, albeit at the cost of the significant losses that usually accompany plasmonics. Both

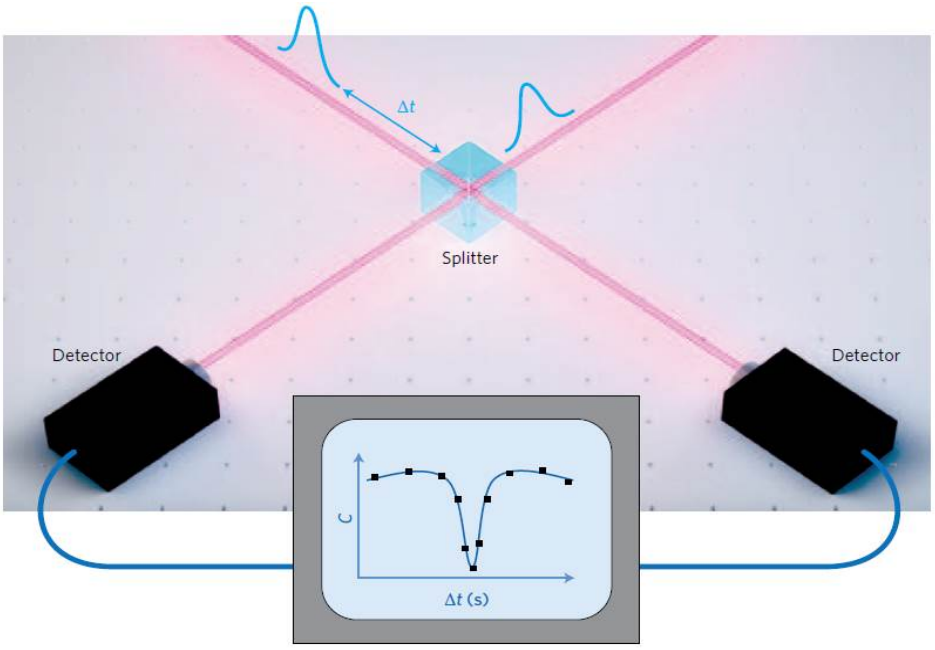


Figure 1 | Hong–Ou–Mandel dip. Researchers have now shown indisputable quantum interference between two single photons in plasmon waveguides. See Box 1 for an explanation of the HOM interference phenomena.

Congratulations to Thomas Meany on his publication and multiple news coverage.

T Meany, L A Ngah, M J Collins, A S Clark, **R J Williams**, B J Eggleton, **M J Steel**, **M J Withford**, O Alibart, S Tanzilli, "Hybrid photonic circuit for multiplexed heralded single photons", *Laser & Photon. Reviews,* 8 (3), L42-L46 (2014) DOI: 10.1002/lpor.201400027

Abstract: A key resource for quantum optics experiments is an on-demand source of single and multiple photon states at telecommunication wavelengths. This letter presents a heralded single photon source based on a hybrid technology approach, combining high efficiency periodically poled lithium niobate waveguides, low-loss laser inscribed circuits, and fast (>1 MHz) fibre coupled electro-optic switches. Hybrid interfacing different platforms is a promising route to exploiting the advantages of existing technology and has permitted the demonstration of the multiplexing of four identical sources of single photons to one output. Since this is an integrated technology, it provides scalability and can immediately leverage any improvements in transmission, detection and photon production efficiencies.

The Register®

http://www.theregister.co.uk/2014/04/02/single_chip_photon_source_brings_quantum_comms_closer/

Single chip photon source brings quantum comms closer

Turning research labs into devices

By Richard Chirgwin, 2 Apr 2014 Follow 2,435 followers

OPTICS & PHOTONICS NEWS

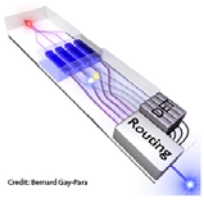
http://www.osa-opn.org/home/newsroom/2014/april/heralded_single_photons_from_a_hybrid_photonic_cir/#.U4ahdyjztM8

Heralded Single Photons from a Hybrid Photonic Circuit

Sarah Michaud

The ability to produce single photons is integral to the success of quantum technologies, including quantum computing. Unfortunately, photons usually arrive in groups. Researchers from Australia and France have brought us a step closer to a reliable single-photon source with their hybrid technology approach (Laser Photon. Rev. DOI: 10.1002/lpor.201400027).

The research team hails from Macquarie University and The University of Sydney in Australia, and the Université Nice Sophia Antipolis in France. The group used a "hybrid integration" approach to combine passive glass routers, nonlinear waveguides in an advanced chip, and fast optical switching elements into an optical device. Lead author Thomas Meany explains, "The hybrid integration approach is a significant departure from the current approach taken by most research groups and is key to the success of our technique. There are a whole host of different



Credit: Bernard Gay-Para

Four-way multiplexed light source showing on-chip photon generation and routing.

50 YEARS STILL DIFFERENT

MACQUARIE UNIVERSITY SYDNEY ~ AUSTRALIA

http://mq.edu.au/newsroom/2014/03/31/ultrabright-lasers-help-switch-single-photons/

Ultrabright lasers help switch single photons

31 March 2014

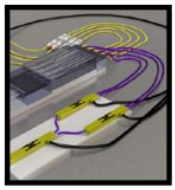
In the search for a single photon source, researchers in Australia and France have achieved a major step towards a turn-key source of individual, precisely tailored photons from an integrated optical chip.

A high quality source of single photons is vital for advances in quantum technologies including simulation of complex molecules, truly secure communication and ultimately quantum computation.

But as Macquarie PhD student and lead author Thomas Meany explains, "Unfortunately, nature is reluctant to create photons one at a time—they tend to come out in bunches. This is a serious impediment we have to overcome in order to make photon sources a useful tool."

Cartoon of the four-way multiplexed light source showing on-chip photon generation and routing, credit Bernard Gay-Para.

AUSTRALIAN OPTICAL SOCIETY



http://www.optics.org.au/aos_news_files/pdfs/2014-1.pdf

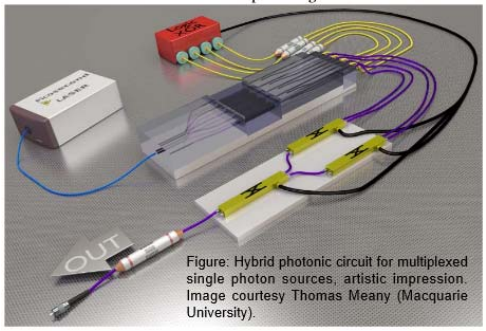


Figure: Hybrid photonic circuit for multiplexed single photon sources, artistic impression. Image courtesy Thomas Meany (Macquarie University).

i-Micronews THE DISRUPTIVE SEMICONDUCTOR TECHNOLOGIES WEBSITE

http://www.i-micronews.com/news/Integrated-chips-used-single-photon-sources,11659.html

> OPTO & PHOTONICS

Apr 7th, 2014

Integrated chips used as single-photon sources

A high-quality source of single photons is hard to come by. But there may be a solution in the pipeline in the form of an integrated optical chip.

Send to a Friend

"Unfortunately, nature is reluctant to create photons one at a time — they tend to come out in bunches," said **Thomas Meany**, a doctoral student at Macquarie University in Sydney and member of a research team studying this topic. *"This is a serious impediment we have to overcome in order to make photon sources a useful tool."*

Such sources are vital to advanced quantum technologies, such as the simulation of complex molecules, secure communications and quantum computing.

The researchers combined optical materials and components into one device to exploit the best of each technology, as there is no single optical device that can perform all of the required operations. Passive glass routers created by femtosecond laser writing were combined with nonlinear waveguides in a highly advanced chip and fast optical switching elements.

Congratulations to Aaron McKay on his publication and multiple news coverage.

A McKay, **O Kitzler**, **R P Mildren**, "Simultaneous brightness enhancement and wavelength conversion to the eye-safe region in a high-power diamond Raman laser," *Laser Photonics Rev.* 8, L37–L41 (2014)

Abstract: Brightness enhancement in an external cavity diamond Raman laser designed for high power conversion of a neodymium (1064 nm) laser to the eye-safe spectral region is reported. Using a multimode input beam pulsed at 36 kHz pulse repetition frequency, 16.2 W with 40% overall conversion efficiency was obtained at the second Stokes wavelength of 1485 nm. The output beam had a quality factor of M2 = 1.17 ± 0.08 which is a factor of 2.7 times lower than that of the input beam, resulting in a higher overall brightness. The output power, brightness, and brightness enhancement obtained represent significant advances in performance for Raman lasers as well as other competing kHz-pulsed eye-safe technologies.

AIP Scitation

http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.7070;jsessionid=1td1ih83guq1a.x-aip-live-02

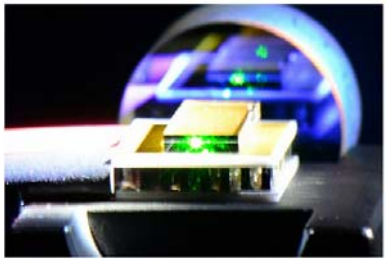
physicstoday

Home | Print Edition | Daily Edition | About | Jobs | Subscribe

A diamond brightness converter

With their exceptional thermal characteristics, diamond crystals offer an efficient way to shift the output of fast, high-power lasers to safer wavelengths.

Richard J. Fitzgerald May 2014



ABC Science

http://www.abc.net.au/science/articles/2014/05/05/3996835.html

News in Science

Share Print

Diamonds are a laser's best friend

Marc Llewellyn
ABC

Monday, 5 May 2014

Australian researchers have developed a unique method of improving the quality of high-powered laser beams using Marilyn Monroe's favourite gemstone.

A girl's best friend they might be, but diamonds also have special properties when it comes to dispersing heat. They have good optical scattering qualities too, effectively reshaping light beams.

According to the lead researcher, Dr Aaron McKay of the Photonics Research Centre at Macquarie University in Sydney, these properties make diamonds much better at producing high quality laser beams than conventional techniques, especially for high power lasers.

LaserFocusWorld

Photonics Technologies & Solutions for Technical Professionals Worldwide

http://www.laserfocusworld.com/articles/2014/05/external-cavity-diamond-raman-laser-increases-pump-brightness-by-50.html

External-cavity diamond Raman laser increases pu brightness by 50%

05/05/2014

By John Wallace

Senior Editor

PHOTONICS.com

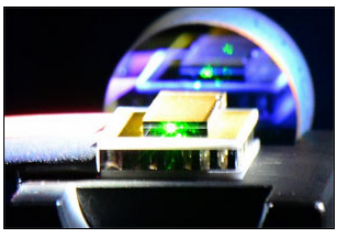
The latest on light research and applications from Photonics Media

http://photonics.com/Article.aspx?AID=56161

Diamond Enhances Laser Beams

SYDNEY, May 7, 2014 — Diamonds just might be a laser beam's best friend.

A team from Macquarie University's Photonics Research Center has discovered how to increase the quality of high-power laser beams by exploiting the optics of an 8-mm diamond.



The diamond-laser device made the brightness of the output beam 50 percent higher than its input beam. Courtesy of Macquarie University.

A 50-W neodymium laser pump beam operating at 1064 nm and pulsed at 36 kHz was converted via stimulated Raman scattering to produce a 1485-nm output beam of 16.2 W — at an overall conversion efficiency of 40 percent. While the input beam had a relatively low quality factor (M^2 = 3 to 4), the output beam achieved a quality factor of M^2 = 1.17 ± 0.08, resulting in a higher overall brightness.

NOVUS LIGHT TECHNOLOGIES TODAY

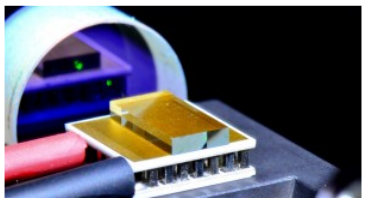
NEWS AND ANALYSIS FROM THE WORLD OF LIGHT

http://www.novuslight.com/diamond-creates-net-increase-in-laser-beam-brightness_N2649.html

Diamond Creates Net Increase in Laser Beam Brightness

Written by Sandra Henderson 19 May 2014

Share 3 | 8+1 1 | Tweet 7 | Share 0 | Email 1



For the first time, researchers at Macquarie University in Sydney, Australia, have exploited optical interactions inside a synthetic diamond crystal to efficiently make

Yabai He, Chunjiang Jin, Ruifeng Kan, Jianguo Liu, Wenqing Liu, Julian Hill, **Ian M. Jamie** & **Brian J. Orr**, "Remote open-path cavity-ringdown spectroscopic sensing of trace gases in air, based on distributed passive sensors linked by km-long optical fibers" ***Optics Express, vol. 22, no. 11, pp. 13170–13189 (2014)*** (on line 22 May) ***… an outcome of MQ's role in the CSIRO Livestock Methane Research Flagship Cluster***

Abstract: A continuous-wave, rapidly swept cavity-ringdown spectroscopic technique has been developed for localized atmospheric sensing of trace gases at remote sites. It uses one or more passive open-path optical sensor units, coupled by optical fiber over distances of >1 km to a single transmitter / receiver console incorporating a photodetector and a swept-frequency diode laser tuned to molecule-specific near-infrared wavelengths. Ways to avoid interference from stimulated Brillouin scattering in long optical fibers have been devised. This rugged open-path system, deployable in agricultural, industrial, and natural atmospheric environments, is used to monitor ammonia in air. A noise-limited minimum detectable mixing ratio of ~11 ppbv is attained for ammonia in nitrogen at atmospheric pressure.

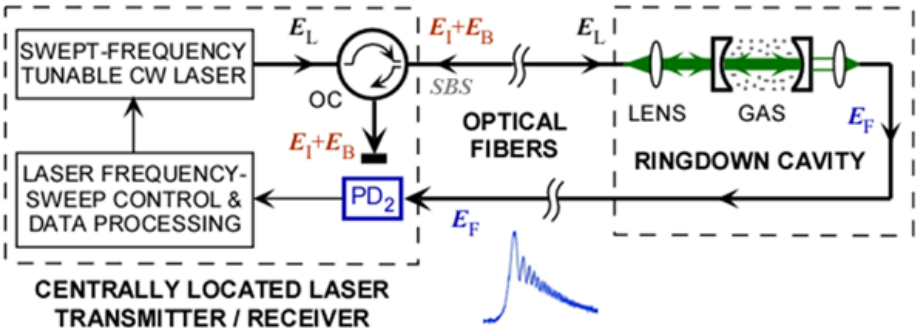


Fig. 4. Alternative layout of a long-fiber-coupled SF cw-CRDS instrument for remote sensing. A second optical fiber and extra coupling optics are used to return forward-propagating cw-CRDS light transmitted by the remote cavity to photodetector PD_2 in the transmitter/receiver console; this avoids SBS interferences that are generated by laser light in long (*e.g.*, >10 m) optical fibers. A corresponding signal waveform is inset in **blue**. The backward-propagating light reflected from the cavity, accompanied by SBS light (labelled in grey), is diverted *via* OC to a beam dump.

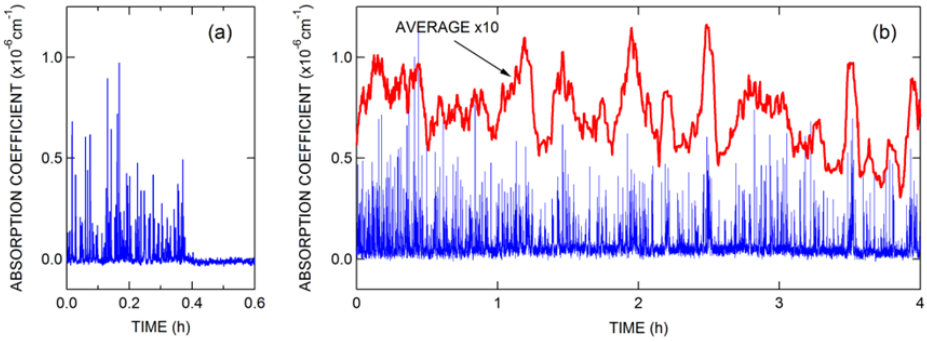


Fig. 10. Open-path SF cw-CRDS measurements (plotted in **blue**) continuously recorded to sense $NH_3(g)$ emissions in outdoor air at ~1531.7-nm (a) over ~20 minutes with ensuing baseline and (b) during a 4-hour period. The **red** plot in Fig. 10(b) is a 300-point (~5-minute) running average (magnified ten-fold on the ordinate scale) of the rapid natural fluctuations in the instantaneous mixing ratio of $NH_3(g)$ in air. As shown in Fig. 7(c), the open-path ringdown-cavity sensor unit was mounted adjacent to a campus garden. The sensor is remotely separated by twin optical fibers (total length $L \approx 1.15$ km) from the optical transmitter/receiver console in a nearby building. The source of $NH_3(g)$ was fertilizer on a ~0.2-m^2 bed of straw in the garden (see text).

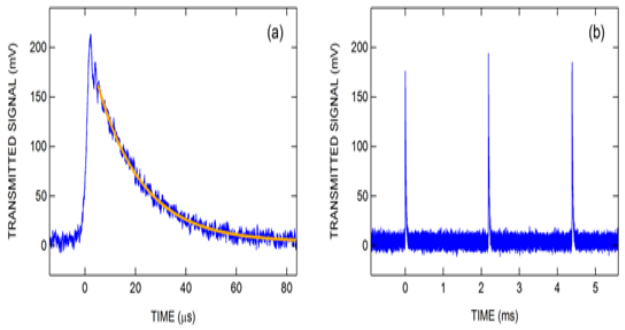


Fig. 5. SF cw-CRDS waveforms measured by using a twin-fiber-coupled forward-propagating instrument as in Fig. 4, with a pair of long (L = 1 km) optical fibers; an exponential-decay fitting curve is superimposed on plot (a). These waveforms are seen to be free of SBS interference.

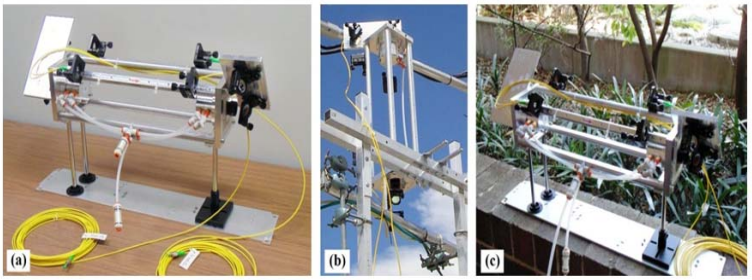


Fig. 8. A passive, pre-aligned open-path ringdown-cavity sensor unit mounted for environmental sensing (a) in the laboratory, (b) on an eddy-covariance tower, and (c) in a campus garden. A pair of yellow-clad single-mode optical fibers connect the sensor unit, *via* free-space coupling optics, to and from the optical transmitter/receiver console that can be located far away (>1 km in experiments reported here). Gas lines to circulate filtered mirror-cleansing air are also visible.

M Murtagh, **J Lin**, **R P Mildren**, **D J Spence**, "Ti:sapphire-pumped diamond Raman laser with sub-100-fs pulse duration", *Optics Letters*, 39 (10), 2975-2978 (2014)

Abstract: We report a synchronously pumped femtosecond diamond Raman laser operating at 895 nm with a 33% slope efficiency. Pumped using a mode-locked Ti:sapphire laser at 800 nm with a duration of 170 fs, the bandwidth of the Stokes output is broadened and chirped to enable subsequent pulse compression to 95 fs using a prism pair. Modeling results indicate that self-phase modulation drives the broadening of the Stokes spectrum in this highly transient laser. Our results demonstrate the potential for Raman conversion to extend the wavelength coverage and pulse shorten Ti:sapphire lasers.

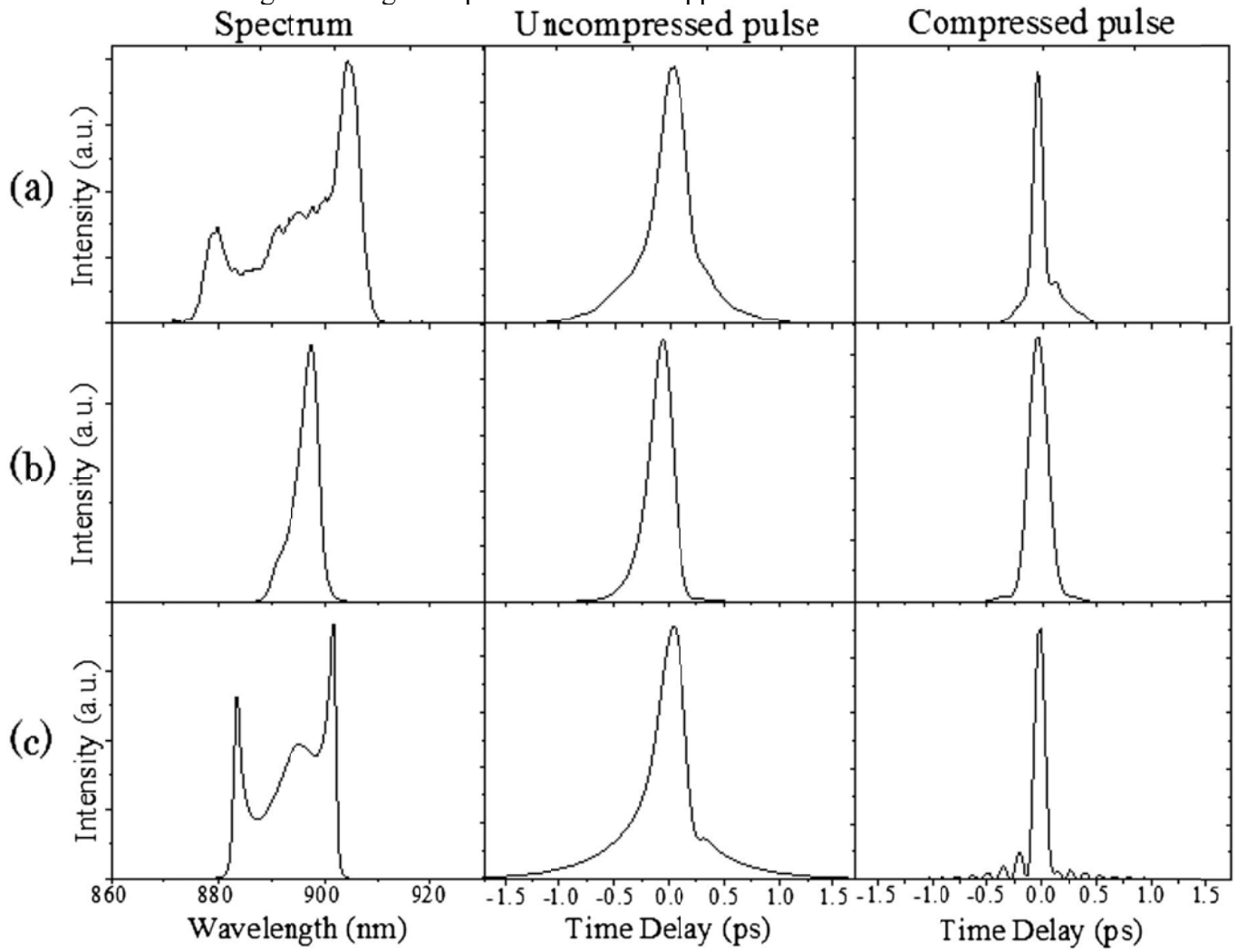


Fig. 3. Comparison of experiment results and theoretical simulations. Row (a) experiment data; (b) simulation without SPM and XPM; (c) simulation with SPM and XPM. The intensity axis for each plot is an arbitrary linear scale.

Y Lu, **J Lu**, **J Zhao**, J Cusido, F M Raymo, J Y, S Yang, R C Leif, Y Huo, **J A Piper**, J P Robinson, **E M Goldys**, **D Jin**, "On-the-fly decoding luminescence lifetimes in the microsecond region for lanthanide-encoded suspension arrays", *Nature Communications*, DOI: 10.1038/ncomms4741

Abstract: Significant multiplexing capacity of optical time-domain coding has been recently demonstrated by tuning luminescence lifetimes of the upconversion nanoparticles called 't-Dots'. It provides a large dynamic range of lifetimes from microseconds to milliseconds, which allows creating large libraries of nanotags/microcarriers. However, a robust approach is required to rapidly and accurately measure the luminescence lifetimes from the relatively slow-decaying signals. Here we show a fast algorithm suitable for the microsecond region with precision closely approaching the theoretical limit and compatible with the rapid scanning cytometry technique.We exploit this approach to further extend optical time-domain multiplexing to the downconversion luminescence, using luminescence microspheres wherein lifetimes are tuned through luminescence resonance energy transfer.We demonstrate real-time discrimination of these microspheres in the rapid scanning cytometry, and apply them to the multiplexed probing of pathogen DNA strands. Our results indicate that tunable luminescence lifetimes have considerable potential in high-throughput analytical sciences.

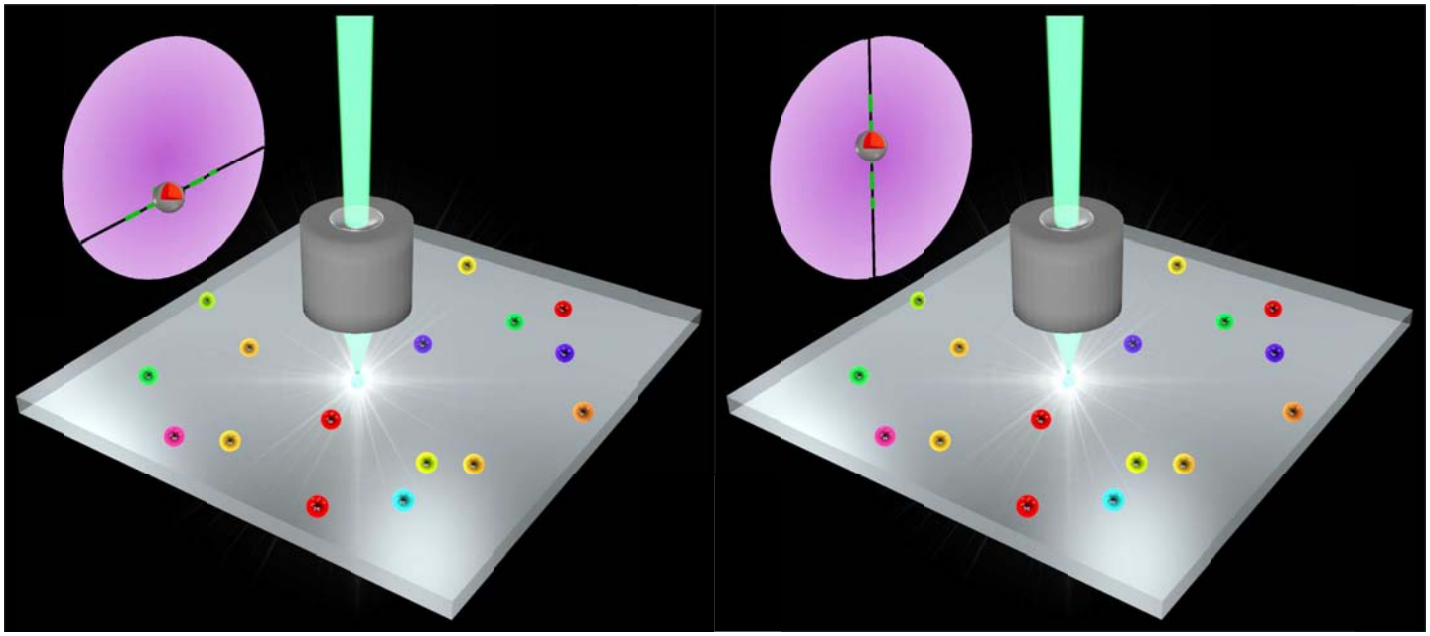


Figure 3 | Schematics of the time-resolved orthogonal scanning automated microscopy (TR-OSAM). The TR-OSAM can identify micron-sized targets randomly distributed on a microscopic slide, and distinguish them by individuals' luminescent lifetimes. (a) It typically takes 3 min to scan and map these targets in background-free condition via pulsed excitation and time-gated luminescence detection. The signal trains of luminescence intensity recorded from the detection field-of-view during the transit of the targets are used to obtain their precise locations along the continuous scanning direction. (b) The positional coordinates guide sequential orthogonal scans for spot-by-spot inspection of targets at the centre of the field-of-view, and the luminescence lifetime identity of each target is decoded in real time.

C G Baldwin, **J E Downes**, **C J McMahon**, **C Bradac**, **R P Mildren**, "Nanostructuring and oxidation of diamond by two-photon ultraviolet surface excitation: An XPS and NEXAFS study", *Phys. Rev. B* 89, 195422 (2014) DOI: http://dx.doi.org/10.1103/PhysRevB.89.195422

Abstract: We report C(1*s*) and O(1*s*) surface sensitive x-ray photoelectron spectroscopy (XPS) and C and O *K*-edge partial-electron yield near-edge x-ray absorption fine structure (NEXAFS) measurements for (100) and (110) oxidized diamond surfaces, etched by a laser two-photon ultraviolet (UV) desorption process. Etched regions of the (100) surface show increased oxygen coverage with a higher fraction of singly bonded termination species than unetched regions. Similar changes are observed for the (110) but with smaller magnitude. For both surfaces, no major change in *sp*2 bonded carbon is observed. We show that the terminations observed for etched surfaces are consistent with the formation of oxidized {111} facets. For deeply etched samples, atomic force microscopy and scanning electron microscopy confirm the presence of {111}-like facets and reveals the development of nanoscale facetted ridges directed perpendicular to the etching beam polarization. An etching mechanism is proposed involving localized optical absorption by surface electronic states, with the probability for subsequent desorption events varying according to the relative directions of laser polarization and lattice orientation.

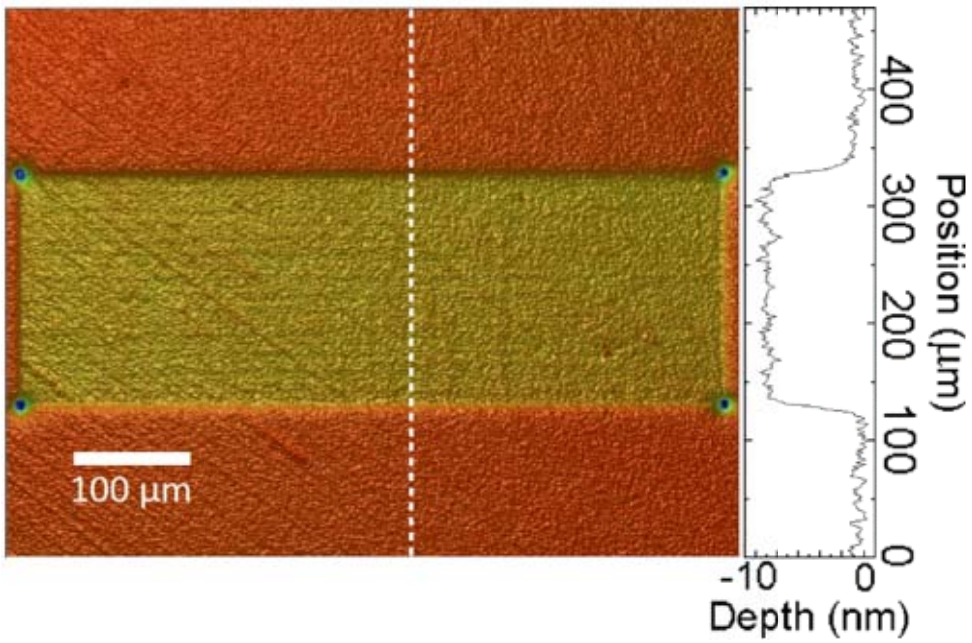


Figure 1

Optical profiler image of the etched (100) surface. The etched region measures 600×200 µm2 and is (9±1) nm deep. In order to assist location of the etched region inside the x-ray analysis chamber, deep pits of depth approximately several hundred nanometres were etched at the corners by stationary exposure of the etching beam for 1 min.

H L An, **A Arriola**, **S Gross**, **A Fuerbach**, **M J Withford**, S Fleming, "Creating large second-order optical nonlinearity in optical waveguides written by femtosecond laser pulses in boro-aluminosilicate glass", *Appl. Phys. Lett.*, Vol. 104 (2), Art. No. 021113 (2014)

Abstract: The thermal poling technique was applied to optical waveguides embedded in a commercial boro-aluminosilicate glass, resulting in high levels of induced second-order optical nonlinearity. The waveguides were fabricated using the femtosecond laser direct-write technique, and thermally poled samples were characterized with second harmonic optical microscopy to reveal the distribution profile of the induced nonlinearity. It was found that, in contrast to fused silica, the presence of waveguides in boro-aluminosilicate glass led to an enhancement of the creation of the second-order nonlinearity, which is larger in the laser written waveguiding regions when compared to the un-modified substrate. The magnitude of the nonlinear coefficient d 33 achieved in the core of the laser-written waveguides, up to 0.2 pm/V, was comparable to that in thermally poled fused silica, enabling the realization of compact integrated electro-optic devices in boro-aluminosilicate glasses.

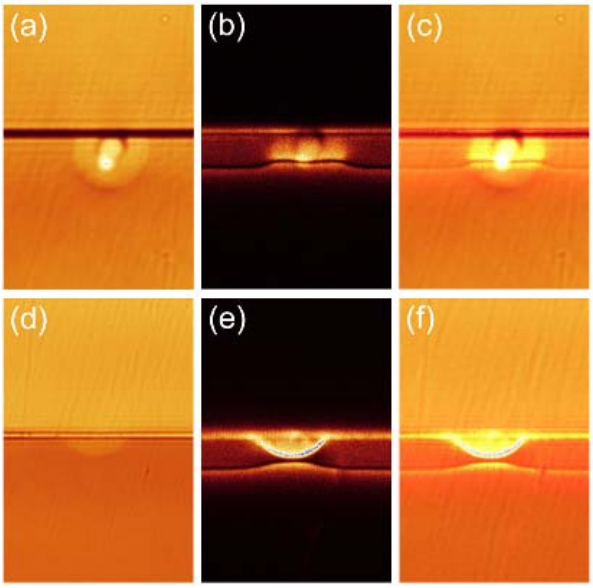


FIG. 4. SH micrographs of the cross-sections of Eagle2000 plates thermally poled at 3.5kV and 335 C for 90min with laser-written waveguides located at different depths under the anode surface. (a) and (d) are ordinary transmission images, (b) and (e) are SH images, and (c) and (f) are overlay images of the corresponding ordinary transmission and SH images.

A McKay, **O Kitzler**, **R P Mildren**, "Thermal lens evolution and compensation in a high power KGW Raman laser," *Optics Express* 22, 6707–6718 (2014)

Abstract: The transient thermal lens in a high-average power double metal tungstate Raman laser has been investigated. An external cavity potassium gadolinium tungstate (KGW) laser designed for second-Stokes output was burst-pumped with up to 46 W of average power at a pulse repetition rate of 38 kHz. At low duty-cycle, the laser generated up to 18 W of on-time average Raman power with a conversion efficiency of 40%. At high duty cycle, efficiency is reduced and the near-field beam profile expands in the *X*1′ crystal direction over a period of tens of milliseconds. The evolution of the spatial beam properties occurs in response to the development of a highly astigmatic thermal lens with fast-axis susceptibility of approximately −1.7 m−1 per watt of Raman output power. We show that the likely cause for astigmatism is primarily photo-elastic in origin. Beam circularization was achieved by incorporating an intracavity convex cylindrical lens.

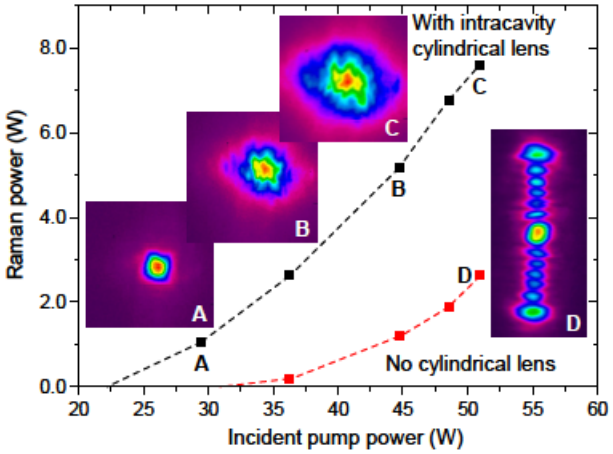


Fig. 6. Output power of the combined Stokes radiation from the KGW Raman laser with (black) and without (red) compensating cylindrical lens. Inset show typical near-field profiles of the Raman output beam at selected power levels.

Seminars

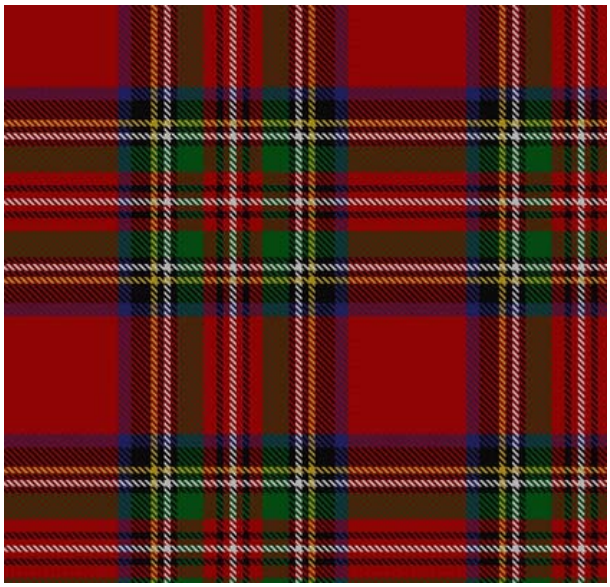
MQ Photonics Seminars:

Time: 12 Noon, Fri 23rd May	Place: W1A level 1 Lecture Theatre	Presented by: Leigh Dayton (Science Writer & Broadcaster @ MQ)
TOPIC: NEWSPEAK – How to talk to journalists		
Time: 12 Noon, Fri 6th June	Place: E6B 2.300	Presented by: Zachary Chaboyer, Vincent Ng
TOPIC: TBA		
Time: 12 Noon, Fri 13th June	Place: W1A level 1 Lecture Theatre	Presented by: **Dr Shaghik Atakaramians,** (IPOS University of Sydney)
TOPIC: TBA		
Time: 12 Noon, Fri 20th June	Place: W1A level 1 Lecture Theatre	Presented by: **Professor Roger Chung** (Australian School of Advanced Medicine)
TOPIC: TBA		
Time: 12 Noon, Fri 27th June	Place: E6B 2.300	Presented by: Blake Entwisle, Glen Douglass
TOPIC: Nanosecond infrared nerve stimulation. Femtosecond laser written spectrographs.		

People and Progress

Deb's Highland Fling …

Deb Kane is touring Scottish universities at present. She and I had a chance chat the day before she left, during which she let slip that her trip is quite prestigious:



Well done, Deb! ***Brian Orr***

The Scottish Universities Physics Alliance (SUPA) supports Distinguished International Visitor Lecture tours. Professor Deb Kane is currently touring and presenting two lectures: "Physversity" and "Nonlinear dynamics of experimental laser systems including complexity analysis" at the University of Dundee, the University of St Andrews and Strathclyde University. The lectures are also being broadcast to other SUPA Departments, from Strathclyde University, via the network used to deliver modules of lectures to postgraduate students and early stage researchers across the collective.

The tour is also an opportunity for Deb to tour laboratories, hold discussions with researchers and seed interaction. Her ongoing collaboration with Professor Thorsten Ackemann at Strathclyde University is being supported by a Royal Society, London, Researcher Exchange Grant.

The Scottish tour follows on from Deb's giving an invited lecture at the Weierstrass Institute for Applied Analysis and Stochastics (WIAS), Nonlinear Dynamics in Semiconductor Lasers Workshop in Berlin (12-14 May).

Farewell to Thomas Meany

The MQ Photonics office space at the Australian Hearing Hub is much quieter following the departure of **Thomas Meany**. Tom brought considerable energy to the group and was always a noticeable presence when around. We wish him well in his current role working as a Researcher at the Cambridge Research Labs – Toshiba, UK under well known quantum scientist Andrew Shields.

Mick Withford

Welcome to Stuart Jackson

It is with great pleasure that we welcome new member **Assoc Prof Stuart Jackson** to the Centre. For those members unfamiliar with Stuart, he did his PhD at Macquarie in the late 90's before heading off to the UK to take up a post-doctoral position at Manchester University under Prof. Terry King. While there Stuart commenced his interest in fibre lasers and mid-IR photonics. Stuart returned to Australia as a Fellow at the Optical Fibre Technology Centre in Redfern and then relocated to the University of Sydney campus following the closure of the OFTC. Stuart is one of several MQ Photonics members affiliated with the Department of Engineering. He will be building a new activity in mid IR photonics in Engineering.

Mick Withford

MQ OSA Student Chapter

The student chapter was involved in the Physics and Astronomy departments Astronomy Open Night in April. The event was once again a success, with over 1000 attendees despite the less than ideal weather. The chapter was happy to be involved in the event by setting up our usual laser graffiti display as well as the laser maze. The maze especially was greeted with a great response, with the room in which we set up the activity proving to be too small for all the participants. Participants could also decorate the metal surfaces around the university grounds with throwable multicoloured LEDs prepared by the chapter before the event. Special thanks go to our volunteers: Vincent Ng, Ondrej Kitzler, Yuwen Duan, Chris Baldwin, Denise Celestino, Alireza Maleki, Sergei Antipov and Zachary Chaboyer.

Zachary Chaboyer