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Wednesday 9 July 08

	Room: Bayside 201	Room: Bayside 202	Room: Bayside 204a	Room: Bayside 204b	Room: Bayside Auditorium A
	WeA: 8:30-10:00 **Optical Transmission Technologies** Presider: Prof. Gee-Kung Chang	**WeB: 8:30-10:00** **Group IV Materials** Presider: John Canning	**WeC: 8:30-10:00** **Photonic Integration 1** Presider: Shinji Tsuji	**WeD: 8:30-10:00** **Microstructured Fiber Technologies** Presider: Ping Shum	**WeE: 8:30-10:00** **Novel Devices** Presider: Jay Sharping
	8:30-9:00 WeA-1 (Invited) **Towards 1TbE using Coherent WDM** A.D.Ellis(1), F.C.G.Gunning(1), B.Cuenot(2), T.C.Healy(3), E.Pincemin(4) (1)Tyndall National Institute and University College Cork Department of Physics, Cork, Ireland (2)now @ JDSU, France (3)Now @ Intune Networks, Ireland (4)Orange Labs, France	**8:30-9:00 WeB-1 (Invited)** **Optical Signal Processing in Silicon Nano-waveguides** Y. Su(1), Q. Li(1), F. Liu(1), Z. Zhang(2), M. Qiu(2) (1)State Key Lab of Advanced Optical Communication Systems and Networks, Department of Electronic Engineering, Shanghai Jiao Tong University, China (2)Department of Microelectronics and Applied Physics, Royal Institute of Technology (KTH), Sweden	**8:30-8:45 WeC-1** **Compact 40-Gbit/s Electroabsorption Monolithically Integrated DFB Laser (EML) Module Integrated With a Driver IC for Very Short Reach Application** T. Yagisawa(1), T. Watanabe(2), T. Ikeuchi(1) (1)Fujitsu Laboratories Limited, Japan (2)Fujitsu Limited, Japan	**8:30-9:00 WeD-1 (Invited)** **Photonic Crystal Fiber for Wide-band Transmission** K. Nakajima, K. Kurokawa, T. Matsui, K. Tajima NTT, Japan	**8:30-8:45 WeE-1** **Highly Efficient Transmission Between 1-D Photonic Crystal Coupled Cavity Waveguides and Straight Waveguides** Y. Kawaguchi, K. Saitoh, M. Koshiba Hokkaido University, Japan
			8:45-9:15 WeC-2 (Invited) **InP Integrated Photonic Circuits for Digital Optical Networking** M. Kato, R. Nagarajan, S. Murthy, S.Corzine, V. Dominic, H. Xu, B. Taylor, P. Evans, J. Pleumeekers, A. Dentai, S. Hurtt, M. Fisher, M. Raburn, M. Missey, A. Chen, D. Lambert, P. Chavarkar, J. Bäck, R.Muthiah, R. Salvatore, C. Joyner, J. Rossi, R. Schneider, M. Ziari, A. Nelson, S. Grubb, F. Kish, D. Welch Infinera, USA		**8:45-9:00 WeE-2** **Surface-Plasmon-Resonance Sensor Based on Suspended-Core Microstructured Optical Fiber** H. Ludvigsen, M. Hautakorpi, M. Mattinen Helsinki University of Technology, Finland
	9:00-9:15 WeA-2 **Experimental Demonstration of Novel Poly-phase OCDM Code** M. Hanawa(1), K. Hosoya(1), M. Nguyen Van(1), K. Nakamura(1), K. Nonaka(2) (1)University of Yamanashi, Japan (2)Kochi University of Technology, Japan	**9:00-9:15 WeB-2** **Polarization Splitter Using Asymmetric Sidewall Long-Period Waveguide Gratings in a Two-Mode Silicon Waveguide** Y.-B. Cho, G.-J. Oh, D.-M. Yeo, S.-Y. Shin(1) Kaist, South Korea		**9:00-9:15 WeD-2** **A Study on Holey Fibers for Wide Band Transmission** K. Imamura, K. Mukasa, R. Sugizaki, T. Yagi Furukawa Electric Co., Ltd., Japan	**9:00-9:30 WeE-3 (Invited)** **Engineering Optical Fibres for Nonlinear Optical Endoscopy** M. Gu Centre for Micro-Photonics, Faculty of Engineering and Industrial Sciences, Swinburne University of Technology, Australia
	9:15-9:30 WeA-3 **Comparison of 44.6-Gbit/s NRZ- and RZ-DQPSK Format in 50-GHz-Spacing ROADM System** T. Yoshimatsu(1), Y. Hashizume(1), S. Yamamoto(1), H. Takara(1), H. Kubota(1) (1)NTT Network Innovation Laboratories, NTT Corporation, Japan (2)NTT Photonics Laboratories, NTT Corporation, Japan	**9:15-9:30 WeB-3** **Reduced Lateral Leakage Losses of TM-Like Modes in Silicon-On-Insulator Ridge Waveguides** K. Kakihara, K. Saitoh, M. Koshiba Hokkaido University, Japan	**9:15-9:30 WeC-3** **43Gb/s Balanced Photoreceiver Using Monolithic Integrated Lensed Facet Waveguide dual-UTC Photodiodes** M. Achouche, C. Cuisin, E. Derouin, F. Pommereau, J.-Y. Dupuy Alcatel-Thales III-V Lab, France	**9:15-9:30 WeD-3** **Experimental Determination of bBands in Solid Core Photonic Bandgap Fibres Using Acoustic Gratings** B. T. Kuhlmey, F. Luan, L. Fu, D.-I. Yeom, B. J. Eggleton CUDOS/The University of Sydney, Australia	
	9:30-9:45 WeA-4 **Colorless Upstream Transmission Using Remote Self-Injection Locked Reflective SOA for WDM-PON** S.-Y. Jung(1), T.-Y. Kim(1), S. H. Han(1), G. Y. Lyu(2), C.-S. Park(1) (1)Gwangju Institute of Science and Technology, South Korea (2)Raybit Systems, Inc., South Korea	**9:30-9:45 WeB-4** **Progress towards achieving diamond waveguides** M. Hiscocks(1), F. Ladouceur(1), K. Ganesan(2), B. Gibson(2), S. Prawer(2) (1)UNSW, Australia (2)Quantum Communications Victoria, UoM, Australia	**9:30-9:45 WeC-4** **Oscillating Characteristics of Self-written Active Waveguide Laser With In-line Cavity** K. Yamashita, M. Ito, A. Kitanobou, E. Fukuzawa, K. Oe Kyoto Institute of Technology, Japan	**9:30-9:45 WeD-4** **Bend Sensitive Wavelength Filtering in Concentric Core Solid Photonic Bandgap Fibre** S. Tanigawa, R. Goto, K. Takenaga, S. Matsuo, M. Fujimaki Optics And Electronics Laboratory, Fujikura Ltd., Japan	**9:30-10:00 WeE-4 (Invited)** **Fiber-top Atomic Force Microscope: A Worthwhile Challenge** K. Smith(1), S. de Man(1), H. Zeijlemaker(2), A. A. Said(3), M. Dugan(3), D. Iannuzzi(1) (1)Vrije Universiteit Amsterdam, The Netherlands (2)FOM Institute AMOLF, The Netherlands (2)Translume Inc., USA
	9:45-10:00 WeA-5 **A Theoretical Investigation of the Effect of the Block Type Dispersion Map upon a Long-Haul RZ-DPSK System** H. Taga, S.-S. Shu, J.-Y. Wu, W.-T. Shih National Sun Yat-Sen University	**9:45-10:00 WeB-5** **Characterisation of Thermally Poled Multilayered Silicate Thin Films** H. An, S. Fleming Optical Fibre Technology Centre, The University of Sydney, Australia	**9:45-10:00 WeC-5** **Reconfigurable Multi-Passband Optical Filter Using Opto-VLSI Processor** M. Aljada, K. Alameh Edith Cowan University, Australia	**9:45-10:00 WeD-5** **Theoretical Design of Multi-Core Photonic Crystal Fiber Based 1x4 Power Splitters** S. Varshney(1), K. Saitoh(1), R. Sinha(2), M. Koshiba(1) (1)Hokkaido University, Japan (2)Delhi College of Engineering, University of Delhi, India	
10:00 - 10:30	**Morning Tea**				
	Room: Bayside 201	Room: Bayside 202	Room: Bayside 204a	Room: Bayside 204b	Room: Bayside Auditorium A
	WeF: 10:30-12:15 **Advanced Modulation Schemes** Presider: Prof. Arthur Lowery	**WeG: 10:30-12:15** **Resonators & Couplers** Presider: TBA	**WeH: 10:30-12:15** **Optical Amplifiers** Presider: Hark Hoe Tan	**WeI: 10:30-12:15** **Fiber Sensors** Presider: Kazunori Mukasa	**WeJ: 10:30-12:15** **Novel Materials & Geometries** Presider: Hanne Ludvigsen
	10:30-11:00 WeF-1 (Invited) **Coherent Optical Communications** K. Kikuchi Department of Electrical Engineering and Information Systems, University of Tokyo, Japan	**10:30-10:45 WeG-1** **Ultra-Low CW Power Wavelength Conversion in High-Index Glass Micro Ring Resonators** D. Moss University of Sydney, Australia	**10:30-11:00 WeH-1 (Invited)** **Fiber Amplifiers for Undersea Application** G. T. Harvey Tyco Telecommunications, USA	**10:30-11:00 WeI-1 (Invited)** **Applications of Fibre Bragg Grating Sensors in Railroad** H.-Y. Tam	**10:30-11:00 WeJ-1 (Invited)** **Diamond Photonics** S. Prawer, A. Greentree
		10:45-11:00 WeG-2 **Triangular Ring Resonator Incorporating Total Internal Reflection Mirror and Compact Multimode Interference Coupler** D. G. Kim Chung-Ang University, South Korea			
	11:00-11:30 WeF-2 (Invited) **Advanced Modulation Format Devices for 40Gb/s and 100Gb/s Optical Telecommunication Systems** Y. Lize	**11:00-11:15 WeG-3** **Chalcogenide Microspheres** G. Elliott, D. Hewak ORC, UK	**11:00-11:15 WeH-2** **All-optical Differentiator Based on Cross-gain Modulation in Optical Parametric Amplifier** K. Wong, J. Chau, K. Cheung The University of Hong Kong, Hong Kong	**11:00-11:15 WeI-2** **Simultaneous Measurement of Temperature and Strain Using Long-Period Fiber Grating Inscribed in Photonic Crystal Fiber Combined with Sagnac Loop Mirror** H.-M. Kim(1), T.-H. Kim(2), D. S. Moon(3), Y.-G. Han(4), Y. Chung(1) (1)GIST, South Korea (2)Youngnam University, South Korea (3)Samsung Electronics Hainan Fiberoptics-Korea Co., Ltd, South Korea (4)Hanyang University, South Korea	**11:00-11:15 WeJ-2** **Doped Iron Garnet Materials for Magnetic Photonic Crystals** M. Vasiliev(1), K. Alameh(1), V. Kotov(2) (1)Electron Science Research Institute, Edith Cowan University, Australia (2)Institute of Microtechnology - Spin MT, Russia
		11:15-11:30 WeG-4 **UV-Written Long-Period Waveguide Grating Coupler** C. K. Chow, K. S. Chiang, Q. Liu, K. P. Lor, H. P. Chan City University of Hong Kong, Hong Kong	**11:15-11:30 WeH-3** **Amplitude-noise and Timing-jitter Reduction via Pulsed Injection Locking of SOA Fiber Ring Laser** M. Oiwa, J. Kim, K. Tsuji, N. Onodera, M. Saruwatari National Defense Academy, Japan	**11:15-11:30 WeI-3** **Magnetic Field Sensor Based on Optical Fiber doped with CdSe Quantum Dots** H. Yang, P. Watekar, S. Ju, W.-T. Han Department of Information and Communications, School of Photon Science and Technology, Gwangju Institute of Science and Technology, South Korea	**11:15-11:30 WeJ-3** **Microfluidic Cavities in Silicon-Based Photonic Crystal Slab Waveguides** U. Bog(1), C. Karnutsch(1), C. Smith(1), B. Eggleton(1), T. Krauss(2) (1)Centre for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS), School of Physics, University of Sydney, Australia (2)School of Physics and Astronomy, University of St Andrews, Scotland
	11:30-11:45 WeF-3 **Bit and Power Loading for Coherent Optical OFDM** Q. Yang(1), W. Shieh(2), Y. Ma(1) (1)Victoria Research Laboratory (NICTA), University of Melbourne, Australia (2)ARC Special Research Centre(CUBIN), University of Melbourne, Australia	**11:30-11:45 WeG-5** **Dynamics in the Writing of Long-Period Gratings in Boron-Doped Fibers by CO2-Laser Pulses** Y. Liu, H. W. Lee, K. S. Chiang City University of Hong Kong, Hong Kong	**11:30-11:45 WeH-4** **Chirp Properties Induced by SOA for Amplification and Wavelength Conversions Measured by an Optical Tunable Bandpass Filter** M. Matsuura, N. Iwatsu, K. Kitamura, N. Kishi Department of Information and Communication Engineering, University of Electro-Communications, Japan	**11:30-11:45 WeI-4** **Ultrasonic Wave Detection using a Simple Design of Optical Fibre Interferometer** H.-C. Wang, S. Fleming Optical Fibre Technology Centre, Australia	**11:30-11:45 WeJ-4** **Laser Induced Generation of Chalcogenide Microspheres and Their Characterisation** C. Grillet, S. Ning Bian, E. C. Magi, B. E. Eggleton CUDOS University of Sydney, Australia
	11:45-12:00 WeF-4 **Decision-feedback Carrier-phase Estimation for Digital Coherent Optical Receivers** Y. Mori, K. Igarashi, K. Katoh, K. Kikuchi The University of Tokyo, Japan	**11:45-12:00 WeG-6** **Fabrication of Benzocyclobutene Multimode Interference Power Splitters** W.-S. Wang, Y.-S. Chang National Taiwan University, Taiwan	**11:45-12:00 WeH-5** **Study of Nonlinear Polarization Rotation in Semiconductor Optical Amplifiers** S. Zhao, C. Wu, M. Cheng, X. Sheng Optical Information, School of Science, Beijing Jiaotong University, China	**11:45-12:00 WeI-5** **Thermal Characteristics of a Fiber Fabry-Perot Etalon Made of PANDA Fiber** M. Tateda, A. Takashi Chiba University, Japan	**11:45-12:00 WeJ-5** **Photo-induced Cavities in Chalcogenide Photonic Crystals** M. Lee, C. Grillet, S. Tomljenovic-Hanic, C. Smith, C. Monat CUDOS, School of Physics, University of Sydney, Australia
	12:00-12:15 WeF-5 **Linewidth-Tolerant Real-Time 10 Gbit/s 16QAM Homodyne Using a Polarization-Multiplexed Pilot-Carrier** M. Nakamura, Y. Kamio, T. Miyazaki National Institute Of Information And Communications Technology (NICT), Japan	**12:00-12:15 WeG-7** **All-fiber Variable Optical Attenuator based on 2x2 Fused Tapered Coupler for High-power Applications** Y. Jeong(1), W. Ha(1), J. K. Kim(1), W. Shin(2), D.-K. Ko(2), J. Lee(2), and K. Oh(1) (1)Institute of Physics and Applied Physics, Yonsei University, Republic of Korea (2)Advanced Photonics Research Institute, Republic of Korea	**12:00-12:15 WeH-6** **Parabolic and Quasi-Parabolic Coupled Propagating Regimes in Optical Amplifiers** V. Kruglov, D. Méchin, J. Harvey University of Auckland, New Zealand		**12:00-12:15 WeJ-6** **High-Q Cavities in Multilayer Photonic Crystal Slabs** S. Tomljenovic-Hanic(1), C. M. de Sterke(1), M. Steel(2), B. Eggleton(1), Y. Tanaka(3) (1)University of Sydney, Australia (2)Macquarie University, Australia (3)Kyoto University, Japan
12:15 - 13:30	**Lunch**				
	Room: Bayside 201	Room: Bayside 202	Room: Bayside 204a	Room: Bayside 204b	Room: Bayside Auditorium A
	WeK: 13:30-15:00 **Performance Monitoring** Presider: TBA	**WeL: 13:30-15:00** **Optical Interconnects & LANs** Presider: Changyuan Yu	**WeM: 13:30-15:00** **VCSEL & DBR** Presider: TBA	**WeN: 13:30-15:00** **Nanowires and Structures** Presider: Mark Pelusi	**WeO: 13:30-15:00** **Devices For Optical Interconnects** Presider: David Moss
	13:30-14:00 WeK-1 (Invited) **Multi-impairment Monitoring – Challenges and Directions** A. Nirmalathas, Y. Zhou, T. Anderson National ICT Australia (NICTA), Victoria Research Laboratory, Dept. of Electrical and Electronic Engineering, The University of Melbourne, Australia.	**13:30-14:00 WeL-1 (Invited)** **Recent Research Progress in Hybrid Fibre-optic In-building Networks** A.M.J. Koonen, H. Yang, H.-D. Jung, Y. Zheng, J. Yang, H.P.A. van den Boom, E. Tangdiongga COBRA Institute, Eindhoven University of Technology, The Netherlands	**13:30-13:45 WeM-1** **Double-path Resonance of a Mode-locked VCSEL Using a Concave Mirror** T. Kato, A. Matsutani, T. Sakaguchi, K. Kobayashi Tokyo Institute of Technology, Japan	**13:30-14:00 WeN-1 (Invited)** **Optical Fibre Nanowire Technology and Applications** G. Brambilla Optoelectronics Research Centre, UK	**13:30-14:00 WeO-1 (Invited)** **Convergence and Integration of Photonics Technology Platform– Enabling Drivers** S. Charbonneau
			13:45-14:00 WeM-2 (Invited) **Fast and Widely Tunable Integrated DBR Lasers** S. Tsuji, H. Arimoto Central Research Laboratory, Hitachi Ltd., Japan		
	14:00-14:15 WeK-2 **Measuring Dispersion in WDM Links with Modulated Background ASE** G. Pendock(1), W. Shieh(1), X. Yi(2), C. Yu(3) (1)Centre for Ultra -Broadband Information Networks, Dept Electrical Engineering, Univeristy of Melbourne, Australia (2)Dept Electrical & Computer Engineering, University of California, USA (3)A*STAR Inst. for Infocomm Research, National University of Singapore, Singapore	**14:00-14:15 WeL-2** **Dynamic Skew Compensation for 40-Gb/s/ch Multi-Wavelength Parallel Transmission with OTN Frame** Y. Sun, T. Ono, A. Takada NTT Network Innovation Laboratories, Japan		**14:00-14:15 WeN-2** **Trimming of Tapered Fiber Ring Resonator by Light Injection** K. Kashiwagi, S. Yamashita The University of Tokyo, Japan	**14:00-15:00 WeO-2 (Tutorial)** **Devices for Optical Interconnects to Chips** D. Miller Ginzton Laboratory, Stanford University, USA
	14:15-14:30 WeK-3 **Novel Signed Chromatic Dispersion Monitoring Technique Based on Asymmetric Waveform Distortion in DQPSK Receiver** H. Kawakami, E. Yoshida, H. Kubota, Y. Miyamoto NTT Network Innovation Laboratories, Japan	**14:15-14:30 WeL-3** **EPON-based Intranet System** M. Hattori, K. Tanaka, Y. Horiuchi KDDI R&D Laboratories Inc., Japan	**14:15-14:30 WeM-3** **Direct Modulation of Photonic Crystal VCSELs** K. Choquette(1), C. Chen(1), D. Siriani(1), P. Leisherr(2) (1)University of Illinois, USA (2)nLight Corporation, Canada	**14:15-14:30 WeN-3** **Kerr Nonlinearity in Small Core Optical Fibres and Nanowires: A Generalised Model, and Application to Mmicrostructured Fibres** S. Afshar, T. Monro Centre of Expertise in Photonics, School of Chemistry & Physics, University of Adelaide, Australia	
	14:30-14:45 WeK-4 **Dynamic Monitoring of Physical Link Performance for Path Computation In Transparent Optical Networks** J. H. Lee, N. Yoshikane, T. Tsuritani, T. Otani KDDI R&D Laboratories Inc., Japan	**14:30-14:45 WeL-4** **Campus-scale Wavelength Routing Network Testbed for Large Contents Distribution Applications** K. Oguchi(1), S. Terada(1), D. Hanawa(1), K. Noguchi(2), A. Okada(2) (1)Seikei University, Japan (2)NTT Photonics Laboratories, Japan	**14:30-14:45 WeM-4** **Optically Pumped Equilateral Triangular Microlasers With Three Mode-selective Trenches** H. Hattori, D. Liu, H. Tan, C. Jagadish The Australian National University, Australia	**14:30-14:45 WeN-4** **Nanostructures in tapered air-silica fibres** C. Rollinson(1), S. Huntington(1), B. Gibson(2), S. Rubanov(3), J. Canning(4) (1)School of Physics, The University of Melbourne, Australia (2)Quantum Communications Victoria, The University of Melbourne, Australia (3)Bio21 Institute, The University of Melbourne, Australia (4)Interdisciplinary Photonics Laboratories, School of Chemistry, University of Sydney, Australia	
	14:45-15:00 WeK-5 **Optical Signal Monitoring of DPSK Signals Using RF Power Detection** C. Lu, J. Zhao The Hong Kong Polytechnic University, Hong Kong	**14:45-15:00 WeL-5** **The Implementation of the DS-SWFQ Mechanism for 10-Gigabit Ethernet Interface** R. Kawate, K. Koguchi, T. Yokotani, K. Shimokasa Mitsubishi Electric Corporation, Japan	**14:45-15:00 WeM-5** **Chaos Synchronisation in Unidirectionally Coupled VCSELs with Polarisation-Preserved and Polarisation-Selected Injection** A. Shore, Y. Hong, M. W. Lee, J. Paul, Pl. Spencer Bangor University, Wales, UK	**14:45-15:00 WeN-5** **Development of Polarization-Maintaining Comb-like Profiled Fiber** M. Takahashi, J. Hiroishi, T. Inoue, M. Tadakuma, Y. Mimura, T. Yagi Furukawa Electric Co., Ltd., Japan	
15:00 - 15:30	**Afternoon Tea**				
	Room: Bayside 201	Room: Bayside 202	Room: Bayside 204a	Room: Bayside 204b	Room: Bayside Auditorium A
	WeP: 15:30-17:00 **Emerging Technologies** Presider: Katsumi Takano	**WeQ: 15:30-17:00** **Long-haul & Core Networks** Presider: Rod Tucker	**WeR: 15:30-17:00** **Photonic Integration 2** Presider: Masaki Kato	**WeS: 15:30-17:00** **High Power Fiber Technologies** Presider: Tanya Monro	**WeT: 15:30-17:00** **Localisation Of Light** Presider: Lindsay Botten
	15:30-16:00 WeP-1 (Invited) **CMOS-Compatible Si Avalanche Photodetectors for Microwave Photonics Applications** W.-Y. Choi, H.-S. Kang Department of Electrical and Electronic Engineering, Yonsei University, Korea	**15:30-16:00 WeQ-1 (Invited)** **Mixed 10/40/100-Gb/s Transmission Through Bandwidth-Managed ROADMs** S. Chandrasekhar, X. Liu Bell Labs, Alcatel-Lucent, USA	**15:30-15:45 WeR-1** **Fabrication of 8 ch DFB-LD-PLC Hybrid Integrated Module With Active Alignment Optical Connection** T. Akutsu(1), J. Hasegawa(1), K. Nara(1), M. Funabashi(2), H. Hasegawa(2) (1)The Furukawa Electric Co., Ltd., Fitel Photonics Lab., Japan (2)The Furukawa Electric Co., Ltd., Yokohama R&D Lab., Japan	**15:30-16:30 WeS-1 (Tutorial)** **Bend Distortion in Large Mode Area Fiber Amplifiers** J. M. Fini OFS Laboratories, USA	**15:30-15:45 WeT-1** **Modelling Time Reversal Experiments in the Optical Domain** B. Marks(1,2), M. Steel(1,2), A. Rahmani(2,3) (1)MQ Photonics Research Centre and Dept of Physics, Macquarie University, Australia (2)Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS), Australia (3)Dept of Mathematical Sciences, University of Technology, Australia
			15:45-16:00 WeR-2 **High-Power Microwave Photodiode Array for Radio over Fiber Applications** T. Nagatsuka, S. Itakura, K. Sakai, Y. Hirano Mitsubishi Electric Corporation, Japan		**15:45-16:00 WeT-2** **Optical Coherent Signal Transmission Through Surface Plasmon and Optical Near Field** M. Fukuda, A. Utsumi Toyohashi University of Technology
	16:00-16:15 WeP-2 **FCC-indoor-mask Compliant UWB-IR Signal Generation** M. Hanawa(1), K. Nakamura(1), K. Nonaka(2) (1)University of Yamanashi, Japan (2)Kochi University of Technology, Japan	**16:00-16:15 WeQ-2** **Comparisons Between Single and Double Sideband Direct-Detection and Coherent Baseband OFDM Optical Transmission** D. Hewitt, N. Nadarajah NICTA Victoria Laboratory, Electrical & Electronic Engineering, University of Melbourne, Australia	**16:00-16:15 WeR-3** **10-Gb/s Full C-band Operation of InP Mach-Zehnder Modulator Co-packaged with Tunable Laser Array under Constant Modulation Voltage** M. Ishikawa, K. Tsuzuki, N. Kikuchi, K. Kasaya, Y. Shibata NTT Photonics Laboratories, NTT Corporation, Japan		**16:00-16:15 WeT-3** **Modes of Composite Defects in 2D Photonic Crystals** K. B. Dossou(1), L. C. Botten(1), S. Mahmoodian(2), R. C. McPhedran(2), C. G. Poulton(1) (1)University of Technology, Sydney, Australia (2)University of Sydney, Australia
	16:15-16:30 WeP-3 **40Gb/s Operation Performance of an Optical Serial-to-Parallel Converter With Phase-Shifted Preamble and Mach-Zehnder Delay Interferometers** G. Yazawa, H. Uenohara Tokyo Institute of Technology, Japan	**16:15-16:30 WeQ-3** **A Central Control Optical Burst Switching Scheme** C. Y. Li, P. K. A. Wai The Hong Kong Polytechnic University, Hong Kong	**16:15-16:45 WeR-4 (Invited)** **Fast Pulsed Mode-locked Lasers** E. Bente(1), M. Heck(1,2), P. Muñoz(3), A. Renault(2), R. Nötzel(1), M.Smit(1) (1)COBRA Research Institute, Technische Universiteit Eindhoven, The Netherlands (2)Laser Centre Vrije Universiteit, The Netherlands (3)Grupo de Comunicaciones Opticas, Universidad Politecnica de Valencia, Spain		**16:15-16:30 WeT-4** **The Role of Dimensionality and Dispersion for Defects in Photonic Crystals** S. Mahmoodian(1), K. Dossou(2), R. McPhedran(1), L. Botten(2), C. M. de Sterke(1) (1)CUDOS, University of Sydney, Australia (2)CUDOS, University of Technology, Sydney, Australia
	16:30-16:45 WeP-4 **A Composite Microwave Photonic Link System For Increased Dynamic Range** K. Gupta, A. Lindsay, R. Lindop, D. Palumbo, T. Priest, A. Vanderklugt Defence Science and Technology Organisation, Australia	**16:30-16:45 WeQ-4** **An Optical Crosspoint Buffered Switching Architecture** L. Cai(1), C.Y. Li(1), P.K.A. Wai(1), A. Xu(2) (1)The Hong Kong Polytechnic University, Hong Kong (2)Pecking Universtiy, China		**16:30-16:45 WeS-2** **High Power Laser Fibers - Comparison of Aluminium and Phosphorus Codoping** J. Kirchhof, S. Unger, A. Schwuchow, S. Jetschke, V. Reichel Institute of Photonic Technology, Germany	**16:30-16:45 WeT-5** **Spatiotemporal Light Localization in Infiltrated Waveguide Arrays** P. D. Rasmussen(1), D. Neshev(2), A. Sukhorukov(2), Krolikowski(2), O. Bang(1) (1)DTU Photonics, Technical University of Denmark, Denmark (2)Nonlinear Physics Centre and Laser Physics Centre, Centre for Ultrahigh bandwidth Devices for Optical Systems, Research School of Physical Sciences and Engineering, Australian National University, Australia
	16:45-17:00 WeP-5 **UWB Monocycle Pulse Generation Based on Transfer Curve of Two Mach-Zehnder Modulators** C. K. Oh, T.-Y. Kim, C.-S. Park Department of Information and Communications, Gwangju Institute of Science and Technology, Republic of Korea	**16:45-17:00 WeQ-5** **Multi Root Node Structure for Dynamic Multi-source Multicasting in IP/MPLS over WDM Networks** S. Hassani, W.-D. Zhong, S. K. Bose Nanyang Technological University, Singapore	**16:45-17:00 WeR-5** **Optical Bistability in a Semiconductor Fiber Laser Incorporating an Electro-Absorption Modulator** M. Depa, L. Chen Department of Electrical and Computer Engineering, McGill University, Canada	**16:45-17:00 WeS-3** **Highly Efficient 70W All-fibre Tm-doped Laser System Operating at 1908nm** G. Frith, A. Carter, B. Samson, J. Farroni, K. Farley, K. Tankala. Nufern, USA	**16:45-17:00 WeT-6** **Nonlinear Surface Modes in Annular Waveguides** X. Zhiyong The Australian National University, Australia

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CMOS-Compatible Si Avalanche Photodetectors for Microwave Photonics Applications

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Abstract – We demonstrate that CMOS-compatible Si avalanche photodetectors (CMOS-APD) are very useful for microwave photonics applications. CMOS-APDs are fabricated with 0.18 ㎛ standard CMOS technology. Using the CMOS-APD, radio-over-fiber systems for IEEE 802.11a WLAN are realized. In addition, fiber-supported 60 GHz self-heterodyne systems are implemented by utilizing the CMOS-APD as a harmonic optoelectronic mixer.

I. Introduction

Silicon photodetectors fabricated with CMOS technology have been investigated for short-range optical access networks and optical interconnects applications [1]-[4]. With the continuous evolution of CMOS technology for high integration level and high performance, CMOS process has become the most powerful platform for all kinds of electronic circuits including digital, mixed-mode, and RF applications. Consequently, CMOS-compatible photodetectors can provide a single-chip solution for optical receivers consisting of photodetectors and necessary electronic circuits in a cost-effective manner. We have reported that low responsivity and limited 3-dB bandwidth of CMOS-compatible photodetectors can be overcome by the avalanche effect [5]. We demonstrate in this paper that CMOS-compatible avalanche photodetectors (CMOS-APDs) can be also used for microwave photonics applications.

This paper is organized as follows. Section II describes the structure and photodetection performance of the CMOS-APD. In section III, we demonstrate radio-over-fiber (RoF) systems for 5-GHz band WLAN using the CMOS-APD. The RoF transmission of 20 Mb/s, 16 quadrature amplitude modulation (QAM) signal at 5.805 GHz is successfully performed. Section IV presents the use of the CMOS-APD as a harmonic optoelectronic mixer, which simultaneously performs photodetection and frequency mixing. By utilizing these multi-functions of the CMOS-APD, we implement fiber-supported 60 GHz self-heterodyne systems.

II. CMOS-APD Structure and Photodetection Characteristics

Fig. 1 shows the cross-sectional diagram of the CMOS-APD. We designed and fabricated the device with 0.18 ㎛ standard CMOS technology without any process modification or special substrate. The PN junction consists of P+ source/drain and N-well regions. In order to block slow diffusion current generated in p-substrate region, photocurrents are collected by multi-finger electrodes on P+ region. Details of device structure and characteristics are given in [5].

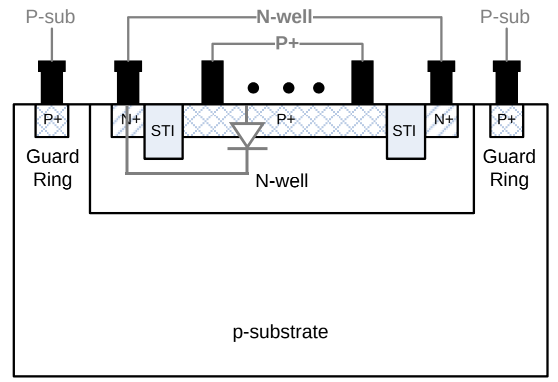

Fig. 1. Schematic cross section of the fabricated CMOS-APD. From [5].

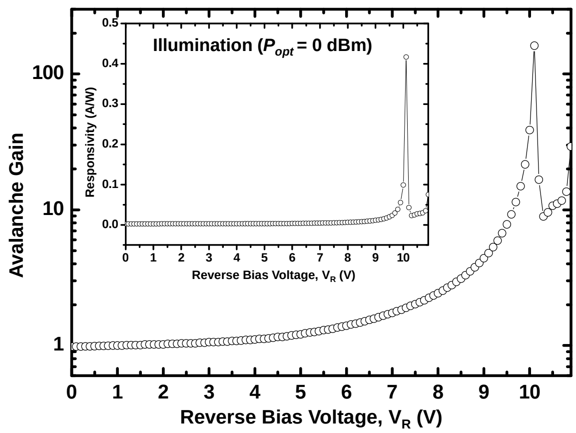

Fig. 2. Avalanche gain and responsivity of the CMOS-APD as a function of V_R. Incident optical power (P_{opt}) is 0 dBm.

Fig. 2 shows avalanche gain and responsivity of the fabricated CMOS-APD for 0 dBm optical signal injection. Avalanche gain and responsivity strongly depends on the electric field applied to the PN junction, and they increase as reverse bias voltage (V_R) increases. Beyond the maximum avalanche gain voltage, avalanche gain starts to decrease due to the space charge effect and thermal heating [5]. With the maximum avalanche gain of 162, the CMOS-APD provides high responsivity of 0.42 A/W at V_R of 10.1 V.

Photodetection frequency responses at different V_R values are investigated and the results are shown in Fig. 3. When applied V_R increases, photodetected signal power increases owing to increased avalanche gain. The CMOS-APD has 3-dB bandwidth of about 3 GHz at V_R of 10.1 V.

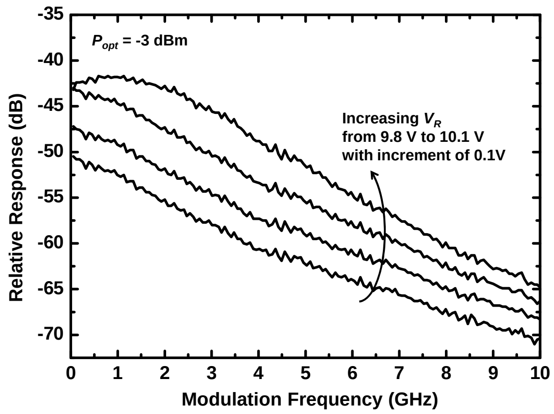

Fig. 3. Photodetection frequency response of the CMOS-APD at different V_R. V_R increases from 9.8 V to 10.1 V with the increment of 0.1 V. Incident optical power is -3 dBm.

III. RoF System for 5-GHz band IEEE 802.11a WLAN

Radio-over-fiber (RoF) systems have been regarded as a promising solution for efficient distribution of radio signals using optical fiber [6]-[11], which can extend the coverage of wireless signals. However, the cost of optical components is a serious obstacle for wide deployment of RoF systems. Several reports for realizing cost-effective RoF systems have been made in which vertical cavity surface emitting laser (VCSELs) and multi-mode fiber (MMF) [9]-[11] were used. However, low-cost implementation of RoF receivers is still a challenge. For this, we have proposed the use of CMOS-APD for 5-GHz band WLAN (IEEE 802.11a) RoF systems [12].

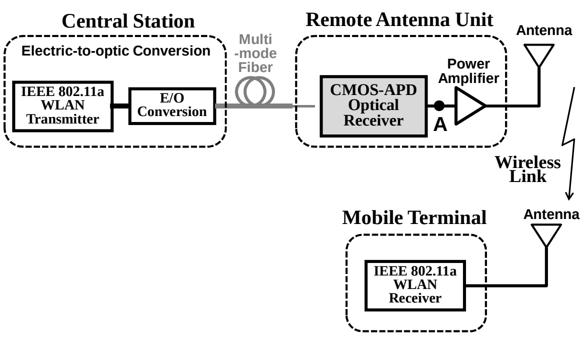

Fig. 4. Schematic diagram of RoF downlink data transmission system for IEEE 802.11a WLAN using CMOS-APD. From [12].

Fig. 4 shows schematic diagram for RoF downlink systems. With the CMOS-APD, it is possible to realize a RoF receiver in which a photodetector is integrated with CMOS RF circuits. We demonstrated RoF transmission of 20 Mb/s, 16 QAM signals at 5.805 GHz using the CMOS-APD. The 5-GHz band WLAN signals were generated using a vector signal generator (Agilent E4432B) and IEEE 802.11a WLAN transceiver (MAXIM 2929EV). For optical modulation of WLAN signals, we used an 850 nm laser diode and an electro-optic modulator. For our demonstration, an external modulator was used. However, directly modulated VCSELs [9]-[11] can be used for further cost reduction. Through 3-m long MMF, optically generated WLAN signals were transmitted to a remote antenna unit and injected into the CMOS-APD using a lensed fiber. After photodetection, WLAN signals were amplified by 40 dB and radiated by a 4 dBi gain omnidirectional antenna. After 40-dB loss of 0.5 m wireless link, received signals were frequency down-converted by an IEEE 802.11a WLAN transceiver, and the down-converted signal quality was analyzed by a vector signal analyzer (Agilent 89441A).

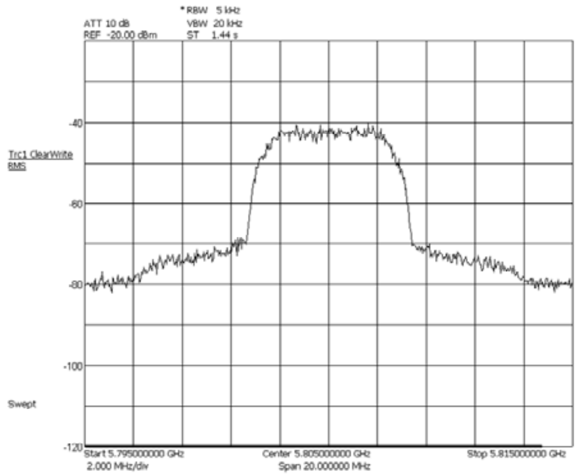

Fig. 5. Photodetected signal spectrum of 20 Mb/s 16 QAM data at the output of the CMOS-APD (Point A in Fig. 4). From [12].

Fig. 5 shows the output signal spectrum of the CMOS-APD when 20 Mb/s, 16 QAM data at 5.805 GHz were RoF transmitted. When the incident optical power into the CMOS-APD was 4 dBm, the signal-to-noise ratio (SNR) was above 20 dB. The bias voltage of 10.1 V was optimized for maximum photodetected signal power. Fig. 6 shows the constellation and eye diagram of demodulated data at the vector signal analyzer. The rms EVM of 5.5 % was obtained with the corresponding SNR of about 22.5 dB. In our experiment, the CMOS-APD requires relatively high optical power to attain high SNR value due to the insufficient optic-to-electric conversion efficiency as well as lack of a transimpedance amplifier. Further improvement is expected with an integrated receiver.

IV. Fiber-supported 60 GHz Self-heterodyne System

In order to meet the growing demand for broadband wireless communications, fiber-supported millimeter-wave wireless systems have attracted lots of attention [13]-[17]. However, for the realization of these systems, the cost of optical and millimeter-wave components is a problem. Because high attenuation loss of millimeter-wave signals reduces the coverage of remote antenna units to the pico- or femo-cell range, a large number of remote antenna units are needed. Previously, multi-functional optical components and III-V phototransistors have been used for cost reduction in fiber-supported millimeter-wave systems [13]-[15]. In addition, we have reported 60 GHz harmonic optoelectronic mixers based on CMOS-APDs for low-cost fiber-supported millimeter-wave systems [16]-[17]. In our scheme, the CMOS-APD performs photodetection and frequency mixing simultaneously.

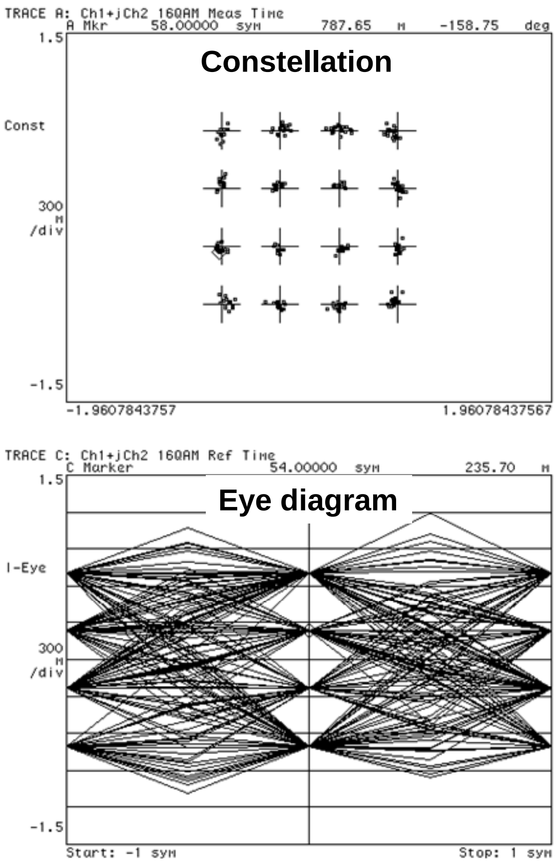

Fig. 6. Constellation and eye diagram of demodulated data when 20 Mb/s, 16 QAM signals are RoF transmitted with a wireless link. From [16].

Fig. 7 shows a schematic diagram for the fiber-supported 60 GHz self-heterodyne wireless system. By utilizing the CMOS-APD as a harmonic optoelectronic mixer, optically modulated data from central station are converted to the electrical signal, and frequency up-converted to the 60 GHz band with only a single device. At the output of the CMOS-APD, frequency up-converted data are amplified, and then radiated along with the LO signal. After transmission of wireless link, received data and LO signal at mobile terminal are self-mixed by a square-law device, resulting in down-converted signals without any phase-locked LO and phase-noise degradation [18].

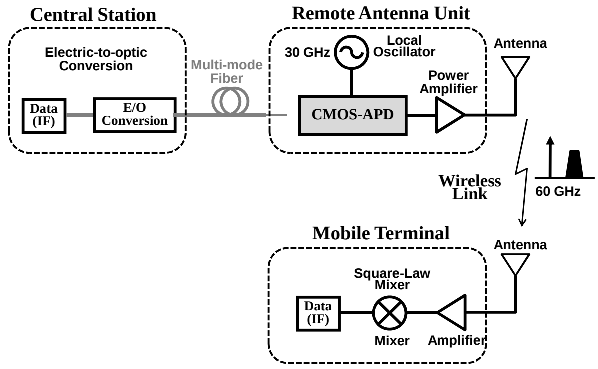

Fig. 7. Schematic diagram of fiber-supported 60 GHz self-heterodyne system utilizing the CMOS-APD as a harmonic optoelectronic mixer. From [16].

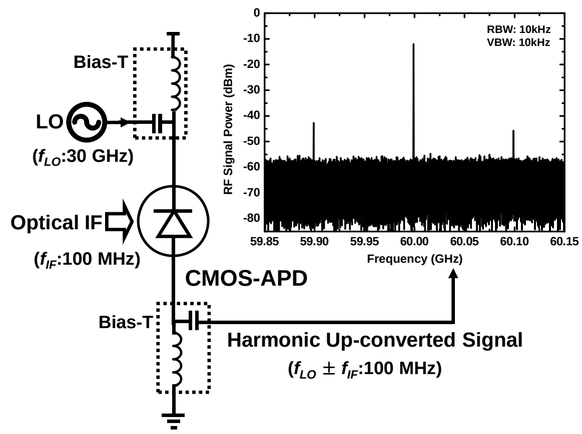

Fig. 8. Configuration of harmonic optoelectronic mixer utilizing the CMOS-APD and the spectrum of harmonic up-converted signal at 60-GHz band.

The harmonic optoelectronic mixing is done by the nonlinear avalanche gain characteristics of the CMOS-APD and detailed description is given in [17]. Fig. 8 shows configuration of the harmonic optoelectronic mixer and its output spectrum when 30 GHz electrical LO and 100 MHz optical IF signals are applied to the device. As can be seen, second harmonic LO at 60 GHz ($2 \cdot f_{LO}$), upper side band (USB) at 60.1 GHz ($2 \cdot f_{LO} + f_{IF}$) and lower side band (LSB) at 59.9 GHz ($2 \cdot f_{LO} - f_{IF}$) are generated.

Utilizing the CMOS-APD as a harmonic optoelectronic mixer, 60 GHz remote up-conversion downlink data transmission was performed. Optically modulated 25 Mb/s, 32 QAM data were transmitted through 3-m long MMF and injected to the CMOS-APD with 30 GHz electrical LO signal. The frequency up-converted signal as well as LO signal at 60 GHz band were transmitted to a mobile terminal, and then frequency down-converted to IF band by a Schottky diode envelop detector followed by a 60 GHz low-noise amplfier. To maximize the harmonic optoelectonic mixing efficiency, the bias voltage of 10.1 V was applied and electrical LO power was set to 20 dBm. Fig. 9 shows constellation and eye diagram of demodulated 25 Mb/s, 32 QAM data. From the experiment, the rms EVM of about 5.1 %, which corresponds to 21.7 dB SNR, was obtained.

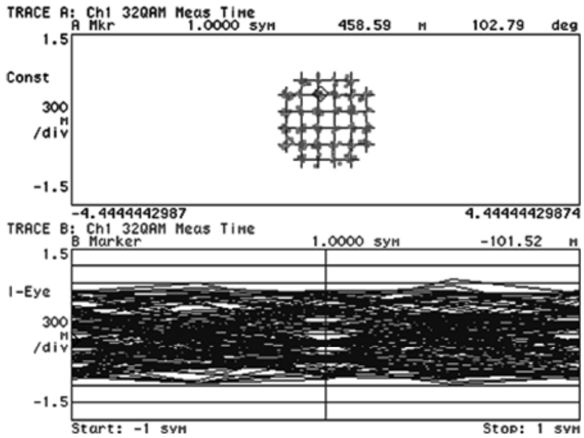

Fig. 9. Constellation and eye diagram of demodulated 25 Mb/s, 32 QAM data. From [16].

V. Conclusions

We demonstrate that the CMOS-APD can be used for microwave photonics applications. Using the CMOS-APD in the 5-GHz band WLAN RoF receiver, 20 Mb/s, 16 QAM data at 54 Mb/s are successfully transmitted. Using the CMOS-APD as a harmonic optoelectronic mixer, a fiber-supported 60 GHz self-heterodyne system is demonstrated.

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