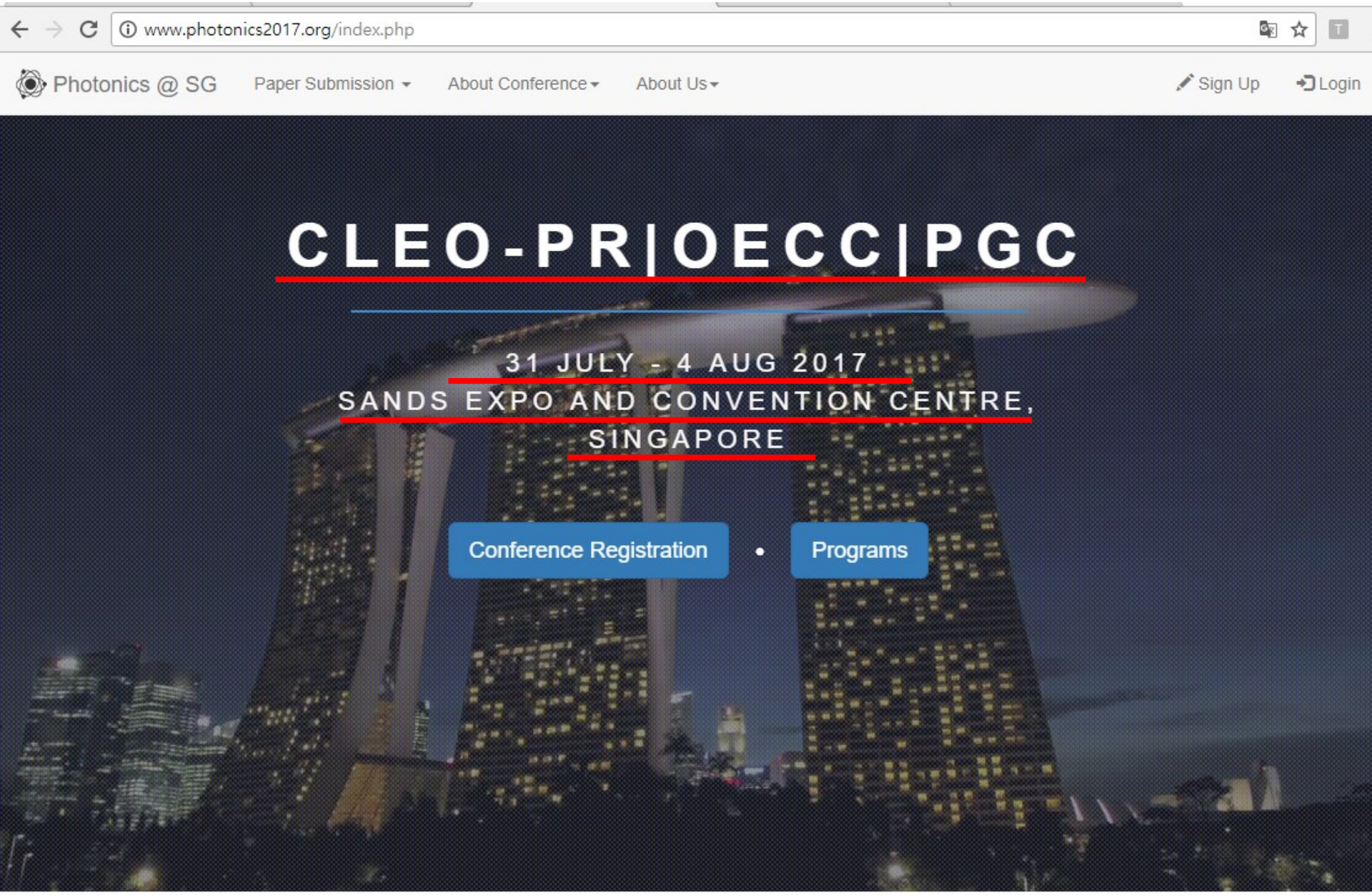
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Session: 2-4	and Applications VI		Fiber Sensors	
16:15-18:00 **Session: 2-4**	Room E: 4503 Photonic Devices - Modulators and Detectors	Room F: 4505 MIR and THz Devices	Room G: 4301 Advanced Photonic Integration	Room H: 4201 Frequency Combs and Precision Measurements
16:15-18:00 **Session: 2-4**	Room I: 4812 Start-Up Challenge	Room J: 4912 Plasmonics and Metamaterials IV	Room K: 4203 Direct-Detection Transmission System	Room L: 4303 Radio-over-Fiber Systems
16:15-18:00 **Session: 2-4**	Room M: 4611 High Power Fiber Laser I	Room N: 4612 Chip-Scale Signaling and Processing on SOI Platforms	Room O: 4613 Photonics	Room P: 4711 Optical Sensor Technology III
16:15-18:00 **Session: 2-4**	Room Q: 4712 Carbon Nanomaterials	Room R: 4713 The Role of Optics in Fronthaul and Backhaul for 5G Networks and Beyond II	Room S: 4811 Photonics Technologies for Primary Point-of-care and Global Health VI	Room T: 4911 Coherence Domain Imaging Technologies
18:30-21:30	**Banquet (Grand Gallery&Ballroom, Level 1, Ritz-Carlton Hotel)**			
Thu. 03 Aug				
08:30-10:15 **Session: 3-1**	Room A: 4401 Fiber-Based Technologies and Applications VII	Room B: 4403 Fiber Sensors II	Room C: 4405 Photonic Sensing and Applications I	Room D: 4501 Microresonators & Nanolasers I
08:30-10:15 **Session: 3-1**	Room E: 4503 Nonlinear Optics and Signal Processing	Room F: 4505 Infrared Technology and Applications	Room G: 4301 Advanced Devices and Circuits	Room H: 4201 Fiber Lasers and Novel Waveguides
08:30-10:15 **Session: 3-1**	Room I: 4812 Photonics Global Student Conference 2017 I	Room J: 4912 New Phenomena in 2D Materials	RoomK: 4203 SDM Transmission	Room L: 4303 Visible Light Communication Systems
08:30-10:15 **Session: 3-1**	Room M: 4611 High Power Fiber Laser II	Room N: 4612 Women In Photonics I	Room O: 4613 Quantum Technologies	Room P: 4711 Advanced Optical Technology
08:30-10:15 **Session: 3-1**	Room Q: 4712 Photonic Applications of 2D Materials	Room R: 4713 Liquid Crystals and Their Applications	Room S: 4811 Microwave Photonics I	Room T: 4911 Nonlinear and Broadband Amplifiers I
10:15-10:45	**Morning Tea, Coffee Break (Room 4701)**			
10:15—11:45	**Poster Session 3 (Room 4603-4604)**			
10:45-12:30 **Session: 3-2**	Room A: 4401 Fiber-Based Technologies and Applications VIII	Room B: 4403 Fiber Laser and Amplifier	Room C: 4405 Photonic Sensing and Applications II	Room D: 4501 Microresonators & Nanolasers II
10:45-12:30 **Session: 3-2**	Room E: 4503 Novel Materials	Room F: 4505 Infrared Emission and Waveguide Fabrication	Room G: 4301 Nano Optical Trapping	Room H: 4201 High Field Physics and Other Topics in Nonlinear Optics
10:45-12:30 **Session: 3-2**	Room I: 4812 Photonics Global Student Conference 2017 II	Room J: 4912 Optoelectronic Properties of 2D Materials	Room K: 4203 Transmission Technologies for Optical Network	Room L: 4303 Optical Access Systems
10:45-12:30 **Session: 3-2**	Room M: 4611 High Power Fiber Laser III	Room N:4612 Women In Photonics II	Room O: 4613 Nitrides, Other Widegap Semiconductors I	Room P: 4711 Lab-in-a-Fiber Technologies I
10:45-12:30 **Session: 3-2**	Room Q: 4712 2D Materials	Room R: 4713 Applications of Spatial Light Modulators	Room S: 4811 Microwave Photonics II	Room T: 4911 Nonlinear and Broadband Amplifiers II
12:30-14:00	**Buffet Lunch (Room 4701)**			
14:00-15:45 **Session: 3-3**	Room A: 4401 Fiber-Based Technologies and Applications IX	Room B: 4403 Specialty Fiber I	Room C: 4405 Integrated Optic Sensors	Room D: 4501 Perovskite Materials and Devices III
14:00-15:45 **Session: 3-3**	Room E: 4503 Silicon Photonics Systems and Applications I	Room F: 4505 Infrared Applications and Commercialization	Room G: 4301 Applications of New Optical Fibers in Communication and Sensing I	Room H: 4201 Nonlinearities in Integrated Photonics and Related Topics

Poster Session 3
Time: 10:15am – 11:45am
Date: 3 Aug 2017

P3-001 Multi-Wavelength Nearly Transform-Limited Gaussian Optical Pulse Generation Using Time Lens
Qiang Wang, Wei Zhang, Jian Xiong
Beijing Institute of Remote Sensing Equipment

P3-002 Non-Orthogonal Multiple Access In Visible Light Communications With Adaptive Loading
Xun Guan, Yang Hong, Chun-Kit Chan
The Chinese University of Hong Kong

P3-003 Analysis of Nonlinear Interference Noise In Flexible Optical Networks
Stefanos Dris, Hadrien Louchet, Andre Richter
VPIphotonics

P3-004 Vector-Based Equalization Method To Mitigate Core-to-Core Q-Difference For Space-Division Multiplexing Transmission
Hidenori Takahashi, Takehiro Tsuritani
KDDI Research, Inc.

P3-005 A Modified Adaptive Least Mean Square Frequency-Domain Algorithm For Equalization Of Polarization Division Multiplexed-Mode Division Multiplexed Fiber Transmission
Shuangxi Zhang, Jianfei Liu, Xiangye Zeng, Jia Lu, Ying Wei, Mengjun Wang
Hebei University Of Technology

P3-006 Experimental Investigation On Impacts Of PAPR Reduction Schemes In OFDM-based VLC Systems
Huimin Lu, Yang Hong, Lian-Kuan Chen, Jianping Wang
University of Science and Technology Beijing

P3-007 100/150/200 Gb/s Real-Time Demonstration Of SD-FEC Employing MSSC-LDPC Codes For Flexible Coherent Transport
Kenji Ishii, Keisuke Dohi, Takafumi Fujimori, Kenya Sugihara, Yoshikuni Miyata, Soichiro Kametani, Susumu Hirano, Kazuo Kubo, Hideo Yoshida, Wataru Mastumoto, Takashi Sugihara
Mitsubishi Electric Corporation

P3-008 Effect Of Number Of Neurons Of A Neural-Network On Compensation Performance Of SPM Non-linear Waveform Distortion.
Yuta Fukumoto, Syotaro Owaki, Moriya Nakamura
Meiji University

P3-009 SPM And Phase-Noise Compensation Using A Polarization-Multiplexed And Intensity-Modulated Pilot-Carrier
Noriki Sumimoto, Ryoichiro Nakamura, Moriya Nakamura
Meiji University

P3-010 Novel Twin-SSB-SC Method Using A DP-QPSK Modulator
Shogo Kashiwagi, Ryoichiro Nakamura, Moriya Nakamura
Meiji University

P3-011 Machine-learning Detector Based On Support Vector Machine For 122-Gbps Multi-CAP Optical Communication System
Sun Lin, Du Jiangbing, Chen Guoyao, He Zuyuan, Chen Xia, T. Reed Graham
Shanghai Jiao Tong University

P3-013 Signal Degradation From Optical Mach-Zehnder Modulators In The Presence Of Electronic-Distortion Compensation
Xiatao Huang, Xingwen Yi, Jing Zhang
University of Electronic Science and Technology of China

P3-014 SPM And Phase-Noise Compensation Using A Time-Division-Multiplexed And Intensity Modulated Pilot-Carrier
Yuya Takanashi, Shotaro Owaki, Ryoichiro Nakamura, Moriya Nakamura
Meiji University

P3-015 Analysis Of The Influence Of Mach-Zehnder Modulator On Photodiode Nonlinearity Measurement
Lijing Li, Jinnan Zhang, Ensen Wu, Yangan Zhang, Minglun Zhang, Xueguang Yuan, Yong Zuo
Beijing University of Posts and Telecommunications

P3-016 Amplitude And Time Skew Aware Equalization Of 100-Gb/s PAM4 Signals At The Transmitter Side For VCSEL-based Short Reach Optical Interconnects
You Yue, Zhang Wenjia, Sun Lin, Du Jiangbing, He Zuyuan
Shanghai Jiao Tong University

P3-017 Mitigation Of Cross-Phase Modulation In WDM Transmission By Mid-Link Electro-Optic Phase Conjugation
Masayuki Matsumoto, Ryohei Obata
Wakayama University

P3-018 Optical Vortex Propagation In Few-mode Rectangular Polymer Waveguides
Vladimir S. Lyubopytov, Arkadi Chipouline, Urs Zywietz, Boris Chichkov, Grigorii S. Sokolovskii, Nikita S. Averkiev, Grigorii M. Savchenko, Vladislav E. Bougrov
Technical University of Denmark

P3-019 Stokes-Space Modulation Format Identification For Coherent Optical Receivers Utilizing Improved Hierarchical Clustering Algorithm
Shengqiang Zhu, Xiong Wu, Jie Liu, Changjian Guo
Sun Yat-Sen University

P3-020 Long Haul Quasi-Single-Mode Transmission Using Raman Amplified Hybrid FMF/SSMF Span For CO-OFDM System
Liang Xu, Jingchi Cheng, Zhenhua Feng, Qiong Wu, Ming Tang, Songnian Fu, Deming Liu, Perry Ping Shum
Huazhong University of Science and Technology

P3-021 Unscented Kalman Filters For Polarization De-multiplexing In 3D Stokes Space
Xiang Qian, Yang Yanfu, Zhang Qun, He Qianwen, Yao Yong
Harbin Institute of Technology

P3-022 Training Symbol Assisted In-band OSNR Monitoring Technique Suitable For Long Haul Raman Amplified PDM-CO-OFDM System
Liang Xu, Qiong Wu, Zhenhua Feng, Ming Tang, Songnian Fu, Deming Liu, Perry Ping Shum
Huazhong University of Science and Technology

P3-023 Polarization Tracking And Channel Equalization With Radius-directed Recursive Least Squares Filter
Qun Zhang, Yanfu Yang, Qian Xiang, Qianwen He, Yong Yao
Harbin Institute of Technology

P3-024 Nonlinear Transmission And Phase Noise Tolerance Of A Novel Circular 16QAM Modulation Formats
Qianwen He, Yanfu Yang, Qun Zhang, Qian Xiang, Yong Yao
Harbin Institute of Technology

P3-025 Low-Complexity Equalizations for PAM4 in Next-Generation Access Network
Tang Xizi, Zhou Ji, Guo Mengqi, Qi Jia, Hu Fan, Qiao Yaojun, Zhang Lin, Lu Yueming
Beijing University of Posts and Telecommunications

P3-026 A Bidirectional Fiber-IVLLC And Fiber-Wireless Convergence System
Zih-Yi Yang, Ming-Te Cheng, De-Yu Chen, Jing-Kai Chi, Yun-Chieh Wang, Chung-Yi Li, Hai-Han Lu
National Taipei University of Technology

P3-027 Performance Investigation Of Polar Coded IM/DD Optical OFDM For Short Reach Interconnection
Jiafei Fang, Shilin Xiao, Ling Liu, Meihua Bi, Lu Zhang, Yunhao Zhang, Weisheng Hu
Shanghai Jiao Tong University

P3-028 Correlation Detection Scheme For Suppression Of Residual Dispersion In Nyquist OTDM
Morimoto Kosuke, Miyoshi Yuji, Kubota Hirokazu, Ohashi Masaharu
Osaka Prefecture University

P3-029 Study On Structural Parameters Of 2-LP Mode Ring-core Erbium-doped Fiber
Shota Miyagawa, Daiki Nobuhira, Osanori Koyama, Makoto Yamada, Hirotaka Ono
Osaka Prefecture University

P3-030 Adaptive Equalization Combined With Maximum Likelihood Decoder For Trellis Code Modulation Based On High-order QAM Signals
Koji Igarashi
Osaka University

P3-031 Transmission Performance Of 3-bit/symbol Modulation Formats In Dispersion-Unmanaged Link
Tomofumi Oyama, Hisao Nakashima, Yohei Koganei, Yuichi Akiyama, Takeshi Hoshida
Fujitsu Laboratories Ltd.

P3-032 Iterative Decoding Between Feed-forward Carrier Recovery And FEC Decoding To Compensate For Laser Phase Noise
Shuai Yuan, Koji Igarashi
Osaka University

P3-033 Impact Of Transceiver Noise And Polarization Mode Dispersion On Digital Back-Propagation Performance
Lidia Galdino
University College London

P3-034 Transmission Scheme For Supressing Nonlinear Signal Degradation Using Correlation Detection
Masafumi Nakaoka, Yuji Miyoshi, Hirokazu Kubota, Masaharu Ohashi
Osaka Prefecture University

P3-035 Quadrature-Amplitude-Coding PAM To Improve Bandwidth-Limitation Tolerance For Short-Reach Transmission
Akira Masuda, Shuto Yamamoto, Yoshiaki Sone, Shingo Kawai, Mitsunori Fukutoku
NTT Network Service Systems Laboratories Nippon Telegraph and Telephone Corporation

P3-036 High Dispersion Tolerant Optical Duobinary PAM4 Signal For Data Center Communications
Yan Jhih-Heng, Yeh Tzu-Yu, Chang Yen-Hsiang, Wu Yi-Chen, Feng Kai-Ming
National Tsing Hua University

P3-037 High-Density Multi-Carrier Optical Transmission Using MIMO-Based Subcarrier Crosstalk Compensation
Kohei Saito, Takashi Kotanigawa, Hideki Maeda
NTT Network Service Systems Laboratories Nippon Telegraph and Telephone Corporation

P3-038 Four-Wave Mixing In Optical Phase Conjugation System With Pre-Dispersion
Abdallah Ali, Christian Costa, Mohammad Al-Khateeb, Filipe Ferreira, Andrew Ellis
Aston University

P3-039 RIN And Transmission Performance Improvement Using Second Order And Broadband First Order Forward Raman Pumping
Md Asif Iqbal, Mingming Tan, Atalla El-Taher, Paul Harper
Aston University

P3-040 Pump Phase-Locking Method Dependence Of ND-PSA Repeaters On Multi-Span Transmission Of QPSK-PCTWs In Dispersion Compensated Links
Yasuhiro Okamura, Shingo Seki, Atsushi Takada
Tokushima University

P3-041 Joint Tracking and Mitigation of Linear Dynamic Impairments Using a 3-stage Extended Kalman Filter in Fiber Channel
Hengying Xu, Yiqiao Feng, Nannan Zhang, Linqian Li, Liangze Cui, Xiaoguang Zhang, Chenglin Bai
Beijing University of Posts and Telecommunications

P3-042 Filters Embedded Optical Planar Splitter Connectable To Large Core Plastic Optical Fibers
Václav Prajzler, Radek Maštera
Czech Technical University in Prague

P3-043 A Hybrid Multiplexer For Wavelength/mode-division At 1310nm/1550nm
Ke Ji, Heming Chen
Nanjing University of Posts and Telecommunications

P3-044 Polarization-Diversified-Loop-Based Simple Tunable Zeroth-Order Fiber Multiwavelength Filter
Yong Wook Lee, Dokyeong Kim
Pukyong National University

P3-045 Polarization Filter Based On A Novel Photonic Crystal Fiber With A Gold-coated Air Hole By Using Surface Plasmon Resonance
Shuqin Lou, Wan Zhang, Xin Wang
Beijing Jiaotong University

P3-046 The Ethanol Gas Sensor By Using A Long Period Grating And ZnO-SnO_2 Materials
Hung-Ying Chang, Wen-Fung Liu, Teng-Lung Wang, Ming-Yue Fu, Hsing-Cheng Chang, Yu-Liang Hsu
Feng-Chia University

P3-047 Long-Period Fiber Grating Fabricated By 800 nm High-Intensity Femtosecond Laser Pulses
Yani Zhang, Sicong Liu, Qiang Xu, Ya Zhao, Yaru Xi
Baoji University of Arts and Science

P3-048 Fiber Bragg Grating Inscribed Independently In Multi-core Fibers With UV Laser
Weihong Bi, Peng Jiang, Yuefeng Qi, Guangwei Fu, Xinghu Fu, Wa Jin, Neng Zhao
Yanshan University

P3-049 Design Of Bend Resistant Large Mode Area Fiber With A Multi-layer Core
Xin Wang, Shuqin Lou, Chenguang Tian
Beijing Jiaotong University

P3-050 Highly Birefringent Anti-resonant Hollow Core Fiber For Low Loss THz Transmission
Xin Wang, Shibo Yan, Shuqin Lou
Beijing Jiaotong University

P3-051 Influence Of Stokes Pulse Power On SBS Fast Light In Optical Fibers
Shanglin Hou
Lanzhou University Of Technology

P3-052 Fabrication And Characterization Of A Single-ended Ultra-thin Spherical Microbubble
Wang Guanjun, Ruan Yinlan, Gui Zhiguo, Liao Changrui, Wang Yiping, Tang Jun
Shenzhen University

P3-053 Variable Aperture In Far Field Technique To Measure The Effective Area For High Order Modes Of Few Mode Fibers
Yusuke Koike, Masaharu Ohashi, Hirokazu Kubota, Yuji Miyoshi
Osaka Prefecture University

P3-054 Longitudinal Structural Fluctuations Monitoring Of PBG And Anti-resonant Hollow-Core Fibers Based On Bulk And Surface Brillouin Scattering
Sheng Liang, Xinzhi Sheng, Shuqin Lou, Xin Wang
Beijing Jiaotong University

P3-055 Broadband Higher-Order Mode Pass Filter Based On Mode Conversion
Kazi Tanvir Ahmmed, Hau Ping Chan, Binghui Li, Zhe Huang
City University of Hong Kong

P3-056 Temperature Sensing Of Side-polished Optical Fiber With Polymer Nanostructure Cladding
Li Tang, Yongchun Zhong, Jianhui Yu, Huihui Lu, Heyuan Guan, Zhe Chen
Jinan University

P3-058 Design Of A High-Speed Electro-Absorption Modulator Based On Graphene And Microfiber
Yongqiang Xie, Jiayuan Li, Ke Xu
Harbin Institute of Technology

P3-059 Surface-Plasmon PCF-based Sensor In Hollow-Core Photonic Crystal Fiber
Jung-Sheng Chiang, Jr-Shian Shie, Wei-Chih Wang, Nai-Hsiang Sun
I-Shou University

P3-060 Point-by-point Inscription Of Bragg Gratings In A Multicore Fibre
Martynas Beresna, Yongmin Jung, John Hayes, Dave Richardson, Gilberto Brambilla

University of Southampton

P3-061 25-Gbaud PAM4 And 1300nm Directly Modulated Laser Diode Using Low Parasitic Electrodes For Long-distance Transmission
Yi-jen Chiu, Rih-You Chen
National Sun Yat-Sen University

P3-062 Multicore Fiber Enabled Parallel Mach-Zehnder Interferometers For Sensing Application
Li Duan, Xuan Zhan, Ming Tang, Ruoxu Wang, Songnian Fu, Deming Liu
Huazhong University of Science and Technology

P3-063 Attenuation Coefficient And Bending Loss Measurement Of Few-mode Fibers By Utilizing Variable Mode Power Ratio
Nozoe Saki, Matsui Takashi, Taruno Masaaki, Kubota Hirokazu, Tsujikawa Kyozo, Ohashi Masaharu, Nakajima Kazuhide
Nippon Telegraph and Telephone Corporation

P3-064 Low-cost Temperature Sensors Using Mechanical Long Period Fiber Grating In 850 nm-wavelength Range
Yasuhiro Tsutsumi, Takahiro Hase, Masaharu Ohashi, Yuji Miyoshi, Kubota Hirokazu
Osaka Prefecture University

P3-065 Rotational Speed Sensors Based On A Fiber Bragg Grating
Hung-Ying Chang, Chuan-Ying Huang, Wen-Fung Liu, Jia-Guan Li, Chan-Yu Kuo, Ming-Yue Fu
Feng-Chia University

P3-066 Noise Tolerance In Optical Waveguide Circuits For Recognition Of Optical 8QAM Codes
Tumendemberel Surenkhorol, Kishikawa Hiroki, Goto Nobuo
Tokushima University

P3-067 Chromatic Dispersion Measurement Of The High Order Mode In A Few-Mode Fiber Using An Interferomeric Technique And A Mode Converter
Ryuki Miyazaki, Masaharu Ohashi, Hirokazu Kubota, Yuji Miyoshi, Nori Shibata
Osaka Prefecture University

P3-068 Coupled W-type Four-core Fiber With Low Differential Mode Group Delay For C+L Band
Dongdong Cheng, Jiajing Tu, Xian Zhou, Keping Long, Kunimasa Saitoh
University of Science and Technology Beijing

P3-069 High Sensitivity Refractometer Based On Long-Period Fiber Gratings With High Diffraction Order Mode At Turning Point
Zuyao Liu, Yunqi Liu, Chengbo Mou, Fang Zou, Tingyun Wang
Shanghai University

P3-071 Observation Of Fano Resonances In A Reflective Fiber Coupled Microcavity
Huawen Bai, Xiaobei Zhang, Jiawei Wang, Ming Yan, Yong Yang, Hai Xiao, Fufei Pang, Tingyun Wang
Shanghai University

P3-072 Microlens Fabricated On Fiber Tip Using UV-curable Resin For Optical Interconnect
Yuzafirah Yaacob, Chiemi Fujikawa, Satoru Nakajima, Osamu Mikami, Sumiaty Ambran
University Technology Malaysia

P3-073 Temperature-dependent Characteristics Of Bismuth-doped Fiber Amplifier Operating In A 1720-nm Band
Sergei Firstov, Konstantin Riumkin, Sergey Alyshev, Vladimir Khopin, Mikhail Melkumov, Alexey Guryanov, Evgeny Dianov
Fiber Optics Research Center of the Russian Academy of Sciences

P3-074 Electro-optic Switching In Liquid Crystal Core Waveguide At 1550 nm Wavelength
Mukesh Sharma, M.R. Shenoy, Aloka Sinha
Indian institute of Technology

P3-075 Optical Beam Splitting and Switching Based on Arrays of Tilted Bragg Gratings in Planar Waveguides
Nina Podoliak, Matthew T. Posner, James C. Gates, Peter G. R. Smith, Peter Horak
University of Southampton

P3-076 Reduction On Optical Polysilicon Waveguide Loss By Using Sub-wavelength Gratings In Bulk CMOS Process
Lin Cheng-Chieh, Tsai Ming-Ju, Lee Tsung-Han, Lee San-Liang, Chen Tse-Hung, Hung Yung-Jr
National Taiwan University of Science and Technology

P3-077 Silicon 16-QAM Optical Modulator Driven By Four Binary Electrical Signals
Jianfeng Ding, Sizhu Shao, Lei Zhang, Xin Fu, Lin Yang
Institute of Semiconductors, CAS

P3-078 SOI-based Subwavelength Grating Polarization Beam Splitter With Focusing Ability
Gang Wu, Yongqing Huang, Xiaofeng Duan, Wenjing Fang, Xiaomin Ren
Beijing University of Posts and Telecommunications

P3-079 An Asymmetric Spherical-shape Structure Strain Sensor Based On Few Mode Fiber
Xinghu Fu, Siwen Wang, Jiangpeng Zhang, Qiang Liu, Guangwei Fu, Weihong Bi
Yanshan University

P3-080 A Simple and Accurate Criterion to Calculate the Optimal Length of a Nonlinear Waveguide
Jiabi Xiong, Yu Yu, Weili Yang, Yi Wang, Xinliang Zhang
Huazhong University of Science and Technology

P3-081 Low-voltage Silicon Optical Modulator With A Single-drive Parallel-push-pull Scheme
Shao Sizhu, Ding Jianfeng, Zhang Lei, Fu Xin, Yang Lin
Institute of Semiconductors, Chinese Academy of Sciences

P3-082 Gain Property Of The Few Mode Er-doped Silica Fiber
Wang Jie, Wen Jianxiang
Shanghai University

P3-083 Miniature Fabry-Perot Interferometer Strain Sensor Based On An Elliptical Air Bubble
Cailing Fu, Shen Liu, Jun He, Changrui Liao, Ying Wang, Yiping Wang
Shenzhen University

P3-084 High Temperature Characteristic Of LPFG Fabricated With CO_2 Laser Under Long-term Heating
Makoto Matsui, Toshinori Murakami, Osanori Koyama, Syo Takasuka, Makoto Yamada
Osaka Prefecture University

P3-085 Robust Reconfigurable Optical Mode Mux/Demux Using Multiport Directional Couplers
Rui Tang, Takuo Tanemura, and Yoshiaki Nakano
The University of Tokyo

P3-086 A Low Loss GI-4LP Mode Transmission Fiber With Low DGD
Hongyan Zhou, Lei Zhang, Peng Li, Liyan Zhang, Jing Li, Honghai Wang, Ruichun Wang, Lei Shen
State Key Laboratory of Optical Fibre and Cable Manufacture Technology

P3-087 Thermo-optic Switchable Mode Multiplexer Based On Cascaded Vertical Waveguide Directional Couplers
Quandong Huang, Kin Seng Chiang, Wei Jin
City University of Hong Kong

P3-088 A Stable Microsphere Whispering Gallery Mode Resonator
Weiping Chen, Dongning Wang
China Jiliang University

P3-089 On-site Measurement Of The Birefringence Of Optical Waveguides With A Mach-Zehnder Interferometer
Ze Bing Zhong, Huang Xuguang
South China Normal University

P3-090 Wideband Multimode Fiber For High Speed Short Wavelength Division Multiplexing System
Rong Huang, Runhan Wang, Wufeng Xiao, Liyan Zhang, Yaping Liu, Jing Li, Jihong Zhu, Honghai Wang, Ruichun Wang
State Key Laboratory of Optical Fiber and Cable Manufacture Technology

P3-091 Fiber Microaxicon Lens Fabricated By Focused Ion Beam Milling For Efficient Fiber-to-Waveguide Coupling
Henrik Melkonyan, Karen Sloyan, Krishna Twayana, Paulo Moreira, Marcus Dahlem
Masdar Institute

P3-092 Brillouin Gain Linewidth Variation Depend On The Optical Fiber Winding Conditions
Taeoh Kim, Minkyu Kang, Seongjin Hong, Sanggwon Song, Aeri Jung, Jimyung Kim, Seongmook Jeong, Kyunghwan Oh
Yonsei University

P3-093 The Real-time Imaging By Broadband Supercontinuum Using A Time-stretch Technology
Mary Fung, K.S. Tsang, Victor Ho, Kevin L.F. Lui, Ray Man
Amonics Ltd.

P3-094 Study Of Solute Migrations Induced In An Organic Solution By Short Pulses And Continuous Light
Tai-Huei Wei
National Chung-Cheng University.

P3-096 Demonstration Of Real-Time Path Monitoring In Optical Switches
Takayuki Kurosu, Satoshi Suda, Kiyo Ishii, Shu Namiki
National Institute of Advanced Industrial Science and Technology

P3-097 Cellular Automata In Arrays Of Photonic Cavities
Rimi Banerjee, Timothy C.H Liew
Nanyang Technological University

P3-098 Space-Time-Coded Reconfigurable Card-to-Card Optical Interconnects With Broadcast Capability
Ke Wang, Ampalavanapillai Nirmalathas, Christina Lim, Kamal Alameh, Efstratios Skafidas, Hongtao Li
Royal Melbourne Institute of Technology

P3-099 Four-Port Optical Switch For Photonic Network-on-chip
Hao Jia, Yuhao Xia, Jianfeng Ding, Lei Zhang, Xin Fu, Lin Yang
Inistitute of Semiconductor

P3-100 Widely Tunable Filter Based On Guided-mode Resonant Grating With Liquid Crystal Cladding
Wang Chun-Ta, Hou Hao-Hsiang, Chang Ping-Chien, Li Cheng-Chang , Jau Hung-Chang , Hung Yung-Jr, Lin Tsung-Hsien
National Sun Yat-Sen University

P3-101 LCoS-based Programmable Spectrum Cutter with Programmable and Reconfigurable Filtering Shape For Software Defined Optical Network
Ze Li, Min Zhang, Dequan Xie, Danshi Wang, Yue Cui, Qi Yang
Beijing University of Posts and Telecommunications

P3-102 Tuning Wettability Of Water On Au
John Canning, Kevin Cook, Md. Arafat Hossain
University of Technology Sydney

P3-103 ESD Polarity Effect Study Of Monolithic, Integrated DFB-EAM EML For 100/400G Optical Networks
Jack Jia-Sheng Huang
Source Photonics

P3-104 Athermal Condition Of Magneto-optic Waveguides In Optical Isolator Employing Nonreciprocal Guided-Radiation Mode Conversion
Salinee Choowitsakunlert, Rardchawadee Silapunt, Kenji Takagiwa, Hideki Yokoi
Shibaura Institute of Technology

P3-105 Polarization Bistable Single Fundamental Mode Photonic Crystal VCSELs
Yiyang Xie
Beijing University of Technology

P3-106 High-Power InP-Based Parallel-Connected Uni-traveling Carrier Photodiode Array
Jiarui Fei, Yongqing Huang, Tao Liu, Xiaokai Ma, Xiaofeng Duan, Kai Liu, Xiaomin Ren
Beijing University of Posts and Telecommunications

P3-107 A Compact And Low-loss GeSn Electroabsorption Modulator Using Vertical Multimode Interference For Mid-infrared Ge-on-Si Platform
Minami Akie, Takanori Sato, Masakazu Arai, Takeshi Fujisawa, Kunimasa Saitoh
Hokkaido University

P3-108 Bulk-Silicon-Based Waveguides And Bends
Bonwoo Ku, Kyoung-Soo Kim
Ulsan National Institute of Science and Technology

P3-109 Theoretical Investigations Of Excitonic Absorption In Quasi Two-dimensional CdSe Nanoplatelets
Sumanta Bose, Weijun Fan, Dao Hua Zhang
Nanyang Technological University

P3-110 Strain Profile And Size Dependent Electronic Bandstructure Of Type-I CdS/CdSe Quantum Ring
Sumanta Bose, Weijun Fan, Dao Hua Zhang
Nanyang Technological University

P3-111 Inp-Based Single-Frequency Single-Facet 1x2 MMI Teardrop Laser Diodes
Hua Yang
Tyndall National Institute

P3-112 Design And Growth Of Metamorphic Sb-based Materials On GaAs Substrate For Mid-Infrared Photonic Devices
Yoshimoto Keita, Yamagata Yuya, Imamura Yuga, Arai Masakazu
University of Miyazaki

P3-113 Wavelength Range Extension By Chirped And Nitrogen Incorporated InGaAs(N) Quantum Wells For Super Luminescent Diode
Yuga Imamura, Keita Yoshimoto, Masakazu Arai
University of Miyazaki

P3-114 High-suppression-ratio Silicon Bandpass Filter Using Apodized Subwavelength Grating Coupler
Boyu Liu, Yong Zhang, Yu He, Xinhong Jiang, Ciyuan Qiu, Yikai Su
Shanghai Jiao Tong University

P3-115 Ultra Small V-shaped Gold Split Ring Resonator With Fundamental Magnetic Frequency Approaching Kinetic Inductance Limitation
L.Y.M. Tobing, Yu Luo
Nanyang Technological University

P3-116 N-type-InAsS/GaSb Heterostructure For Infrared Photodetectors
Jinchao Tong
Nanyang Technological University

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Xiangyu Zhang, Hongjuan Wang, Phil Surman, Yuanjin Zheng
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Yonsei University

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P3-151 Mitigating Fiber Nonlinearity Using Support Vector Machine With Genetic Algorithm
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Soochow University

P3-152 Dynamic Property Investigation Of Optical Burst Injection Locking Lasers

A Monolithically Integrated 25-Gb/s Optical Receiver Based on Photonic BiCMOS Technology

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Abstract— **A high performance 25-Gb/s optical receiver having a Ge PD and BiCMOS electronics is monolithically realized with the photonic BiCMOS technology. Receiver design optimization is done in the standard Si IC design environment using an equivalent circuit model for the Ge PD. The integrated receiver achieves sensitivity of −10-dBm at 10^{-12} BER for 25-Gb/s PRBS $2^{31}-1$ data and consumes 37 mW.**

Keywords-Si photonics, integrated optical receiver, Ge photodetector; transimpedance amplifier;

I. INTRODUCTION

The interface bandwidth requirements for various chip-to-chip, board-to-board, and system-to-system interconnects are continuously increasing, and optical interconnect solutions based on Si Photonics technology are expected to play a key role for satisfying these requirements. In particular, optical receivers composed of 1.3/1.55-μm Ge photodetectors (PDs) monolithically integrated with Si electronics have many advantages since, without any extrinsic electrical connections between PD and receiver electronics, they can provide better performance and smaller footprint in a more cost-effective way [1, 2]. Furthermore, once accurate equivalent circuit models for Ge PDs are available, the entire optical receiver can be designed in the standard Si IC design environment allowing very efficient design optimization. In this paper, we present a high-performance monolithic 25-Gb/s optical receiver containing a Ge PD and BiCMOS electronics realized in IHP's photonic BiCMOS technology, which provides various high-performance photonic devices along with 0.25-μm SiGe BiCMOS electronics on a single Si platform [3].

II. OPTICAL RECEIVER

Fig. 1 shows the schematic diagram of our optical receiver. It includes a waveguide Ge PD with a grating coupler, a transimpedance amplifier (TIA), a single-to-differential buffer (SDB), a post amplifier (PA), and an output buffer (OB). The TIA has the regulated cascode configuration and SDB converts single-ended TIA output signals into fully differential signals. PA has the active feedback configuration that enhances the gain-bandwidth product. OB provides 50-Ω impedance matching to measurement instruments. Fig. 2(a) shows the structure of the waveguide Ge PD, which is the first generation device among Ge PDs developed for IHP's photonic BiCMOS technology. It has responsivity of 0.6 A/W and bandwidth of 30 GHz [4].

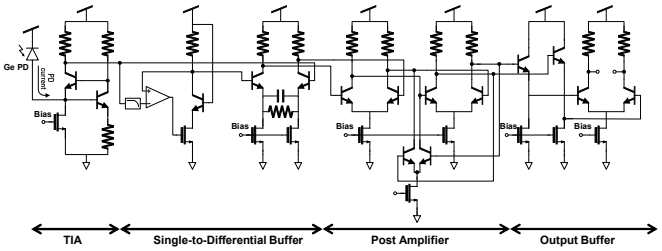
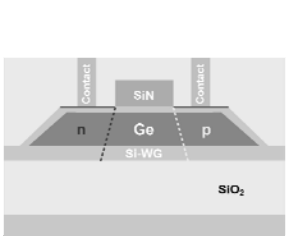
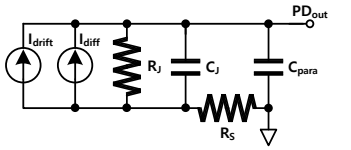


Fig. 1. Schematic diagram of the fabricated optical receiver.





I_{drift} & I_{diff}	f_{3dB_drift}	A_{drift}	f_{3dB_diff}	A_{diff}
	34 GHz	85.6 %	4.7 GHz	14.4 %
RC	C_J	R_s	R_J	C_{para}
	7 fF	90 Ω	100 kΩ	2.3 fF

(a) (b)

Fig. 2. (a) Cross section and (b) equivalent circuit model of the Ge PD.

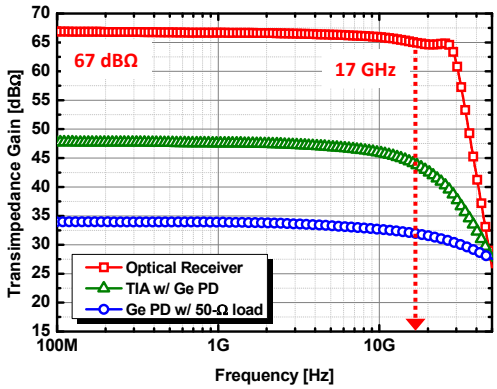
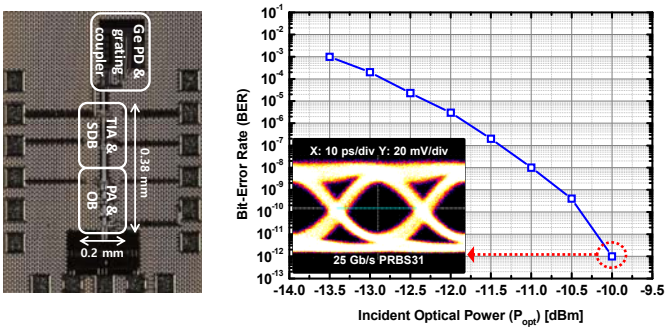


Fig. 3. Simulated photo-detection frequency response for the Ge PD, TIA, and the entire optical receiver.

Fig. 2(b) shows its equivalent circuit model. The model contains two current sources, each of which represents transport of photodetected carriers undergoing drift and diffusion, respectively. Using two current sources provides much more accurate modeling of Ge PD photodetection frequency responses [5, 6]. The model also contains passive elements representing junction capacitance (C_J), junction



(a) (b)

Fig. 4. (a) Microphotograph of the fabricated optical receiver monolithically integrated with Ge PD and (b) Measured BER performance versus incident optical power. Inset shows the measured 25-Gb/s eye diagram.

Table I. Performance comparison of the reported 25-Gb/s optical receivers monolithically integrated Ge PD

	[1]	[2]	[7]	This work
Technology	Photonic BiCMOS	130 nm SOI CMOS	90 nm CMOS	Photonic BiCMOS
Gain (dBΩ)	71	67	-	67
Data rate (Gb/s)	25	25	25	25
BER	10^{-3}	10^{-12}	10^{-12}	10^{-12}
Sensitivity (dBm)	-15	-6	-6	-10
Power (mW)	57	48	-	37
Efficiency (pJ/bit)	2.28	1.92	-	1.5

resistance (R_J), series resistance (R_s) and parasitic capacitance (C_{para}). The bottom table in Fig. 2(b) shows the extracted numerical values for each circuit element at 1-V reverse bias voltage. f_{3dB_drift} and f_{3dB_diff} respectively represent 3-dB bandwidth for drift and diffusion of photo-generated carriers, and A_{drift} and A_{diff} the portion of photogenerated carriers that undergo drift and diffusion [5].

Fig. 3 shows the simulated frequency responses for Ge PD, TIA, and the entire optical receiver. 48-dBΩ transimpedance gain and 20-GHz 3-dB bandwidth are achieved for Ge PD plus TIA. With 18-dB voltage gain and 23-GHz 3-dB bandwidth for PA, the entire optical receiver has transimpedance gain of 67 dBΩ and 3-dB bandwidth of 17 GHz.

III. Measurement Results

The Fig. 4(a) shows the microphotograph of the fabricated optical receiver. The receiver consumes 37 mW with 2.5-V supply. 1550-nm PRBS $2^{31}-1$ 25-Gb/s optical data are generated with a tunable laser and an electro-optic modulator and injected into the receiver through a lensed fiber and the on-chip grating coupler. The receiver output voltages are probed on-chip. Fig. 4(b) shows the measured BER performances at various incident optical powers with the Ge PD biased at -1V. The optical power shown in the figure represents the power delivered into the Ge PD after the grating coupler. The measured receiver sensitivity is −10 dBm at BER of 10^{-12}. The inset of the Fig. 4(b) shows measured eye diagram at incident optical power of −10 dBm. Table I shows the performance comparison of our optical receiver with previously reported 25-Gb/s monolithically integrated optical receivers with Ge PD. As shown in the Table I, our optical receiver achieves high sensitivity of −10 dBm for 10^{-12} BER with small energy efficiency of 1.5-pJ/bit.

IV. Conclusion

A 25-Gb/s monolithic optical receiver is realized with IHP's photonic BiCMOS technology. An accurate Ge PD model provides efficient design optimization and results in high performance. Our receiver achieves sensitivity of −10 dBm at 10^{-12} BER for 25-Gb/s $2^{31}-1$ PRBS input with energy efficiency of 1.5 pJ/bit.

Acknowledgement

This work was supported by National Research Foundation of Korea grant funded by the Korean Ministry of `Science, ICT and Future Planning (2015R1A2A2A01007772) and Materials and Parts Technology R&D Program funded by the Korean Ministry of Trade, Industry & Energy (Project No. 10065666).

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A Monolithically Integrated 25-Gb/s Optical Receiver Based on Photonic BiCMOS Technology

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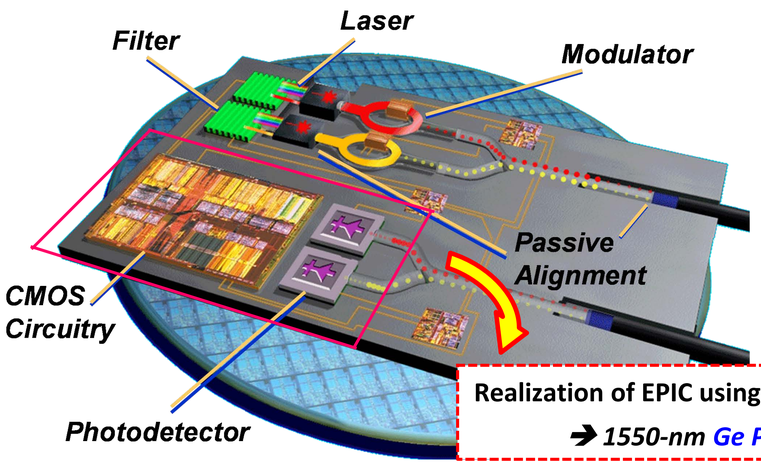
Introduction & Photonic BiCMOS Technology



(Ref. Intel, 2006)

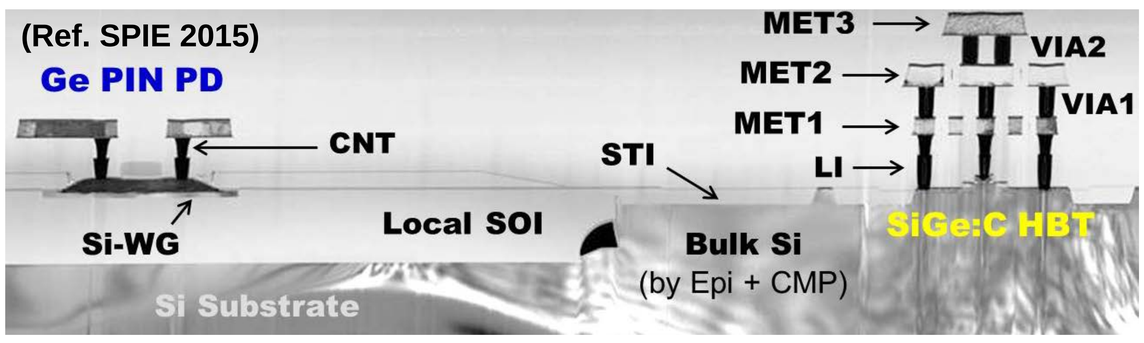
Realization of EPIC using Photonic BiCMOS technology

➔ *1550-nm Ge PD + Electronic Circuits*

- Copper-based electrical interconnect ➔ Interconnect bottleneck !
- Optical interconnect
  - Realization in a cost-effective manner
  - Easy Integration
  - Compatibility with Si foundry service

    ➔ Silicon Photonics !

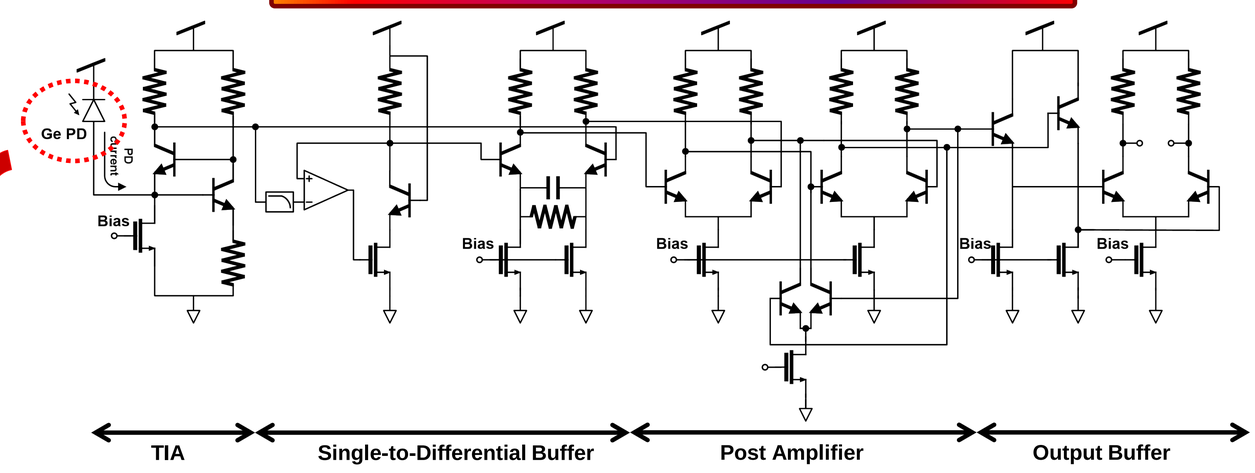
- IHP's Photonic BiCMOS Technology

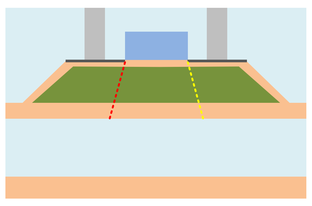


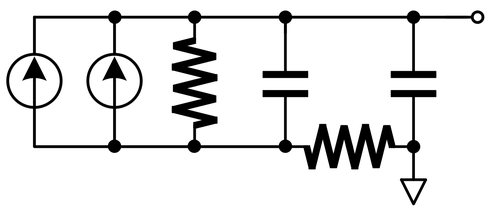
<Ge Photodetector on local SOI> <BiCMOS technology>

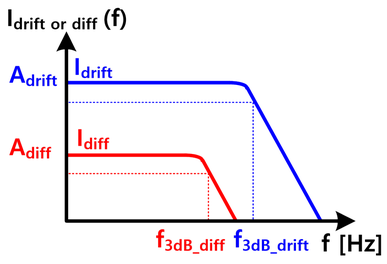
- Electronic circuits
  - 0.25-µm BiCMOS technology
  - HBT & CMOS on bulk Si
- Ge Photodetector
  - Realization on local SOI for photonic components

Monolithic Optical Receiver



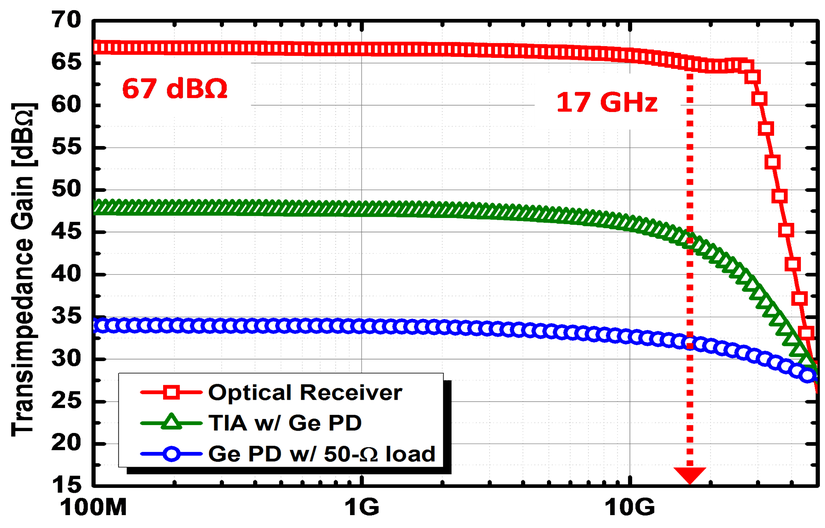






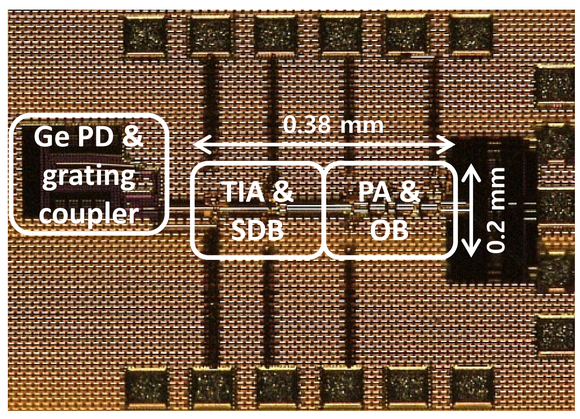
I_{drift} & I_{diff}	$f_{3dB—drift}$	A_{drift}	f_{3dB_diff}	A_{diff}
	34 GHz	85.6 %	4.7 GHz	14.4 %
RC	C_J	R_s	R_J	C_{para}
	7 fF	90 Ω	100 kΩ	2.3 fF

<Cross section and equivalent circuit model of the Ge PD>

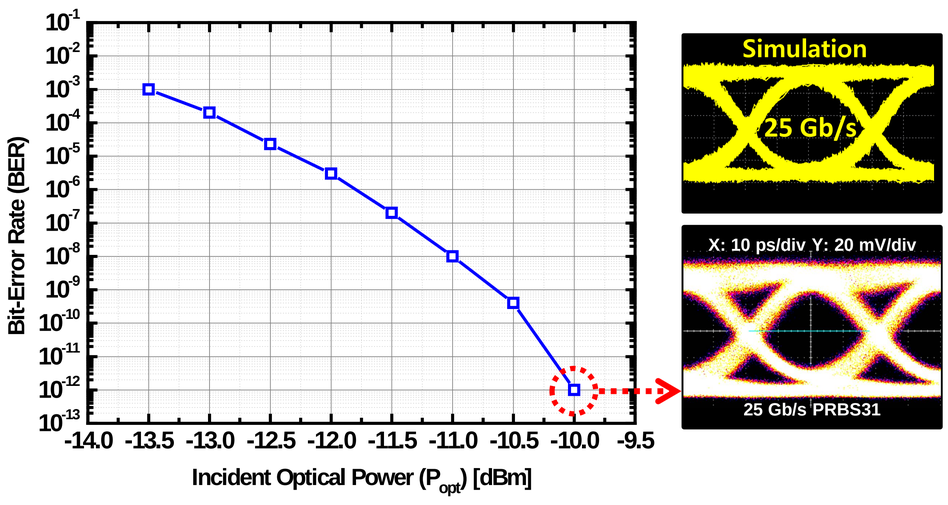


- Photonic BiCMOS Technology (IHP)
- Monolithically integrated Ge photodetector (PD)
  - Waveguide structure
  - 0.6-A/W responsivity and 30-GHz bandwidth
- Accurate equivalent circuit model of the Ge PD including 2 current sources
- Regulated cascode TIA & active feedback post amplifier (PA)

Measurement Results



<Chip photograph>



<BER performance & eye diagram>

	'12 JSSC	'13 OFC	'14 OFC	This work
Technology	130 nm SOI CMOS	90 nm CMOS	Photonic BiCMOS	Photonic BiCMOS
Gain (dBΩ)	67	-	71	67
Data rate (Gb/s)	25	25	25	25
BER	10^{-12}	10^{-12}	10^{-3}	10^{-12}
Sensitivity (dBm)	-6	-6	-15	-10
Power (mW)	48	-	57	37
Efficiency (pJ/bit)	1.92	-	2.28	1.5

<Performance comparison>

- Successful PRBS31 25-Gb/s optical data detection
  - -10-dBm sensitivity for 10^{-12} of BER
- 1.5-pJ/bit energy efficiency for 25-Gb/s operation
- Simulated & Measured eye diagrams are well matched.

Conclusion

- ❖ 1550-nm fully integrated optical receiver with Ge PD in Photonic BiCMOS technology
- ❖ Performance optimization with accurate circuit model of Ge PD
- ❖ Successful 25-Gb/s optical data detection with BER of 10^{-12} at incident optical power of -10 dBm