

# **2022 IEEE International Topical Meeting on Microwave Photonics (MWP 2022)**

**Orlando, Florida, USA  
3-7 October 2022**



**IEEE Catalog Number: CFP22756-POD  
ISBN: 978-1-6654-2122-5**

**Copyright © 2022 by the Institute of Electrical and Electronics Engineers, Inc.  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

**\*\*\* *This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP22756-POD
ISBN (Print-On-Demand):	978-1-6654-2122-5
ISBN (Online):	978-1-6654-2121-8

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

### **TU1: FREE SPACE OPTICS AND ADVANCED SIGNAL PROCESSING**

Ultrathin GHz-Speed Free-Space Electro-Optic Modulators .....	1
<i>Ileana-Cristina Benea-Chelmuș</i>	
Compact OWC Receiver Enabled by Co-Integration of Micro-Lens and PD Arrays on Glass Interposer.....	3
<i>Yuchen Song, Chenhui Li, Ketema A. Mekonnen, Mikolaj Wolny, Carina Ribeiro Barbio Correa, Marc Spiegelberg, Eduward Tangdiongga, Oded Raz</i>	
Spatial Light Modulator Design Optimization for All-Optical Analog-To-Digital Convertors (AOADC) of 40GS/s with 9.4 ENOB .....	7
<i>Joseph Fasbinder, Kai Wei, Afshin S. Daryoush</i>	
All-Digital Optical Phase-Locked Loop for Satellite Communications Under Turbulence Effects.....	11
<i>Jognes Panasiewicz, Nisrine Arab, Fabien Destic, Gefeson M. Pacheco, Angélique Rissons</i>	
Microwave Photonic Phase Shifter Based on the Integration of ITO-Enabled Microheaters.....	15
<i>Suen Xin Chew, Linh Nguyen, Xiaoke Yi</i>	
Analysis on the Phase Noise Degradation of an Optoelectronic Oscillator Submitted to Vibrations.....	19
<i>Pierre Travers, Yohann Léguillon, François Louf, Pierre-Alain Boucard, Loïc Morvan, Daniel Dolfi, Vincent Crozatier</i>	
Compact Integrated Phase Locked Loop for Optical Frequency Difference Locking.....	23
<i>Xiaochuan Shen, Robert Costanzo, Prerana Singaraju, Steven M. Bowers</i>	

### **TU2: MICROWAVE PHOTONIC SIGNAL SOURCES**

Field-Deployable, Ultra-Low Phase Noise Photonic Microwave Oscillators .....	27
<i>Jiang Li, Kerry Vahala</i>	
Low-Phase-Noise Dual-Tone RF Signal Generation Based on an Optoelectronic Oscillator .....	30
<i>Changlong Du, Shifeng Liu, Li Yang, Mingzhen Liu, Dan Zhu, Shilong Pan</i>	
Stable Fabry-Perot Optical Frequency Comb Generation Using Differential Phase Detection.....	34
<i>Xiyi Weng, Wei Wei, Weilin Xie, Yi Dong</i>	
Stable 10 GHz Microwave Synthesis Via Partial Optical Frequency Division .....	38
<i>William Groman, Igor Kudelin, Megan Kelleher, Dahyeon Lee, Alexander Lind, Charles McLemore, Franklyn Quinlan, Scott A. Diddams</i>	
Frequency-Modulated Microwave Signal Generation by Dual-Wavelength Optically Injected Semiconductor Laser .....	41
<i>Xiaoyue Yu, Fangzheng Zhang, Guanqun Sun, Boyang Wu, Shilong Pan, Yuewen Zhou</i>	
Analysis of the Phase Noise Contributions in Optoelectronic Oscillator with Optical Gain.....	45
<i>Guillaume Dangoisse, Perrine Berger, Vincent Crozatier, Frédéric Van Dijk, Christophe Caillaud, Michaël Verdun, Nadège Le Grand, Xavier Prat, Guillaume Canat</i>	

Photonic Microwave Generation Using Period-One Nonlinear Dynamics of Semiconductor Lasers Under Highly Asymmetric Mutual Injection.....	48
<i>Chin-Hao Tseng, Bin-Kai Liao, Sheng-Kwang Hwang</i>	

### **TU3: EMERGING MATERIALS AND DEVICE TECHNOLOGY**

Integrated Microwave-To-Optical Converter Using Patch Antennas on Thin-Film Lithium Niobate .....	51
<i>Farzaneh A. Juneghani, Milad G. Vazimalif, Kim F. Lee, Gregory S. Kanter, Sasan Fathpour</i>	
Transmission and Reception of RF Signals in Power-Over-Fiber Links Powered by Raman Lasers .....	55
<i>Romildo H. Souza, Paulo Kiohara, Laura Guisa, Mikael Guegan, Véronique Quintard, Olympio L. Coutinho, Vilson R. Almeida, André Pérennou</i>	
Linearized Mach-Zehnder Modulators for Microwave Photonic Applications .....	59
<i>Michael J. Morton, Jacob B. Khurgin, Paul A. Morton</i>	
Mach-Zehnder Electro-Optic Modulator with Multimode Interference Couplers of LiNbO <sub>3</sub>	
Waveguides for Single Sideband Modulation .....	63
<i>Shotaro Yasumori, Anna Hirai, Tadashi Kawai, Keita Morimoto, Takanori Sato, Akira Enokihara, Shinya Nakajima, Atsushi Kanno</i>	
Duplex Millimeter-Wave Over Fiber Link Using an InAs/InP Quantum-Dash Mode-Locked Laser.....	67
<i>Yu Huang, Khan Zeb, Guocheng Liu, Philip Poole, Xiupu Zhang, Zhenguo Lu, Ke Wu, Jianping Yao</i>	
Generative Adversarial Network for Data Augmentation in Photonic-Based Microwave Frequency Measurement .....	71
<i>Md Asaduzzaman Jabin, Qidi Liu, Mable P. Fok</i>	

### **TU4: PLENARY SESSION 1**

Chip-Scale Optical Frequency Combs Techniques & Applications.....	75
<i>Peter J. Delfyett, L. Trask, C. Shirpurkar, R. Bustos-Ramírez</i>	

### **WE1: HIGH PERFORMANCE RADIO OVER FIBER SYSTEMS**

Lightwave Modulation for High-Performance Radio-Over-Fiber Systems.....	78
<i>Tetsuya Kawanishi</i>	
FTnet-Based Digital Demodulator for Radio Over Fiber Transmission.....	81
<i>Yue Zhu, Jia Ye, Lianshan Yan, Wei Pan, Xihua Zou</i>	
Attractive Features of Butt Coupling Between Single/Multi Mode GaAs-VCSELs and SSMF for Green, Low-Cost Radio-Over-Fiber Systems.....	85
<i>Jacopo Nanni, Giada Saderi, Gaetano Bellanca, Gianni Bosi, Antonio Raffo, Valeria Vadala, Pierluigi Debernardi, Jean-Luc Polleux, Giovanni Tartarini</i>	
Quasi 2-Bit 32-QAM OFDM Based Digital RoF Link by Delta-Sigma Modulation at 2.5 Gbit/s .....	89
<i>Zu-Kai Weng, Pham Tien Dat, Atsushi Kanno, Tetsuya Kawanishi</i>	
Dispersion Induced-Power Fading Tuned by Power-Over-Fiber on 5G NR Analog Radio Over Fiber Fronthaul Optical Links .....	93
<i>J. D. López-Cardona, R. Altuna, D. S. Montero, C. Vázquez</i>	

WDM Low-Cost and Accurate Delay Monitoring for Delay Calibration of Large Antenna Arrays.....	97
<i>Jacopo Nanni, Enrico Lenzi, Federica Caputo, Jader Monari, Federico Perini, Giovanni Tartarini</i>	

Crosstalk-Based Remote Monitoring Technique for Power Over Fiber Signals in Spatial Division Multiplexing Links .....	101
<i>R. Altuna, J. D. López-Cardona, C. Vázquez</i>	

## **WE2: PHOTONICS FOR THZ AND MMW APPLICATIONS**

Towards Tbit/s THz Communications.....	105
<i>Guillaume Ducournau, Davy P. Gaillot, Aritrio Bandyopadhyay, Malek Zegaoui, Mohammed Zaknoune, Bewindin Alfred Sawadogo, Pascal Sriftgiser, Karen Baudelle, Monika Bouet, Géraud Bouwmans, Esben Andresen, Laurent Bigot</i>	
Proposal and FPGA Implementation of DBSCAN Clustering Nonlinear Detector for MMW RoF System .....	107
<i>Wu Xu, Peixuan Li, Xihua Zou, Ningyuan Zhong, Wei Pan, Lianshan Yan</i>	
Transmission of Millimeter-Wave Radio Signal Over a Seamless Fiber-Terahertz System at 325 GHz .....	111
<i>Pham Tien Dat, Keizo Inagaki, Isao Morohashi, Norihiko Sekine, Atsushi Kanno</i>	
600-GHz-Band Terahertz Imaging Scanner System with Enhanced Focal Depth .....	114
<i>Yaheng Wang, Li Yi, Tadao Nagatsuma</i>	
A Silicon Photonics Automatically-Tunable mm-Wave Remote Antenna Unit .....	118
<i>Ramy Rady, Christi Madsen, Samuel Palermo, Karman Entesari</i>	

## **WE3: PHOTONIC INTEGRATED COMPONENTS AND SUBSYSTEMS**

Heterogeneous Integration of Ultra-Narrow Linewidth Lasers on Silicon for Microwave Photonics.....	122
<i>John E. Bowers, Chao Xiang, Minh A. Tran, Joel Guo, Warren Jin</i>	
Electronic-Photonic Co-Design of Co-Packaged Optics in Schematic-Driven Layout Design Flow for Photonic Integrated Circuits .....	124
<i>Jigesh K. Patel, Enrico Ghillino, Pablo Mena, Dwight Richards, Twan Korthorst</i>	
High-Precision Broadband Silicon Photonics Beamformer .....	127
<i>Pablo Martínez-Carrasco Romero, Daniel Pérez López, Diego Pérez Galacho, Tan Ho, David Wessel, José Capmany Franco</i>	
>110 GHz High-Power Photodiode by Flip-Chip Bonding.....	131
<i>Chao Wei, Xiaojun Xie, Yongtao Du, Ziyun Wang, Jia Ye, Zhongming Zeng, Xihua Zou, Lianshan Yan</i>	
Electro-Opto-Mechanical Microwave-Frequency Oscillator in a Surface Acoustic Wave Silicon-Photonic Circuit.....	135
<i>Maayan Priel, Saawan Kumar Bag, Matan Slook, Leroy Dokhanian, Inbar Shafir, Etaï Grunwald, Moshe Katzman, Mirit Hen, Avi Zadok</i>	
Photonic Beamforming Using Quantum-Dash Mode-Locked Frequency Comb Laser .....	139
<i>Yuxuan Xie, Mostafa Khali, Hao Sun, Lawrence R. Chen, Sehr Moosabhoj, Jiaren Liu, Zhenguo Lu, Philip J. Poole, John Weber</i>	

Design and Analysis of Low Bias, Low Phase Noise Photodetectors for Frequency Comb Applications Using Particle Swarm Optimization.....	143
<i>Ishraq Md Anjum, Ergun Simsek, Seyed Ehsan Jamali Mahabadi, Thomas F. Carruthers, Curtis R. Menyuk</i>	

## **TH1: ADVANCED RADIO OVER FIBER TECHNOLOGIES**

5G/NR Conformance Testing of Analog Radio-Over-Fiber Fronthaul Links .....	147
<i>Rafael Puerta, Oskars Ozolins, Anders Djupsjöbacka, Vjaceslavs Bobrovs, Sergei Popov, Xiaodan Pang</i>	
Coherent Microwave Photonic Links with Increased Transmission Capacity .....	151
<i>Long Huang, Zhenguo Lu, Ke Wu, Jianping Yao</i>	
Convergence Between Terahertz and Optical Systems for 6G and Beyond Networks .....	155
<i>Atsushi Kanno</i>	

## **TH2: QUANTUM APPLICATIONS AND PHOTONIC RADAR SYSTEMS**

Quantum Enabled Radar Sensing .....	159
<i>Jonathan M. Jones, Darren Griffiths, Jithin Kannanthara, Mohammed Jahangir, Michail Antoniou, Christopher Baker, Kai Bongs, Yeshpal Singh</i>	
Quantum Master Equation for a Lossy Josephson Traveling-Wave Parametric Amplifier.....	163
<i>Yongjie Yuan, Michael Haider, Christian Jirauschek</i>	
Adaptive Multipath Optical Self-Interference Cancellation Based on Deep Reinforcement Learning .....	167
<i>Xiao Yu, Jia Ye, Lianshan Yan, Xihua Zou, Wei Pan</i>	
High-Resolution Near-Field Imaging with a Microwave Photonic Broadband Array Radar .....	171
<i>Yuewen Zhou, Shilong Pan, Fangzheng Zhang, Jinhu Li, Guanqun Sun, Jiayuan Kong</i>	
Multi-Static Multi-Band Synthetic Aperture Radar (SAR) Constellation Based on Photonic Processing.....	175
<i>Manuel Reza, Salvatore Maresca, Filippo Scotti, Gaurav Pandey, Muhammad Imran, Giovanni Serafino, Muhammad Haris Amir, Federico Camponeschi, Paolo Ghelfi, Antonella Bogoni, Mirco Scaffardi</i>	
Optical Emulation of Inverse Synthetic Aperture Radar .....	179
<i>Lucio De Pra, Michael Benker, Yifei Li, Tariq Manzur</i>	
Ultra-Stable Wideband Signal Transfer for Distributed Systems.....	183
<i>Xi Wang, Wei Wei, Weilin Xie, Yi Dong</i>	

## **TH3: NOVEL SENSING AND PROCESSING SYSTEMS**

Biomimicry in Microwave Photonics and Soft Robotic with Fiber Optics Sensors.....	187
<i>Mable Fok, Qidi Liu, Mei Yang</i>	
Low-Cost Covert Wireless Communication Assisted by Optical Frequency Comb for Deep Denoising .....	190
<i>Fangge Fu, Bing Lu, Xianglei Yan, Mingliang Deng, Long Zhu, Andong Wang</i>	

Experimental Implementation of an All-Optical Reservoir Computer Using Photonic Time Stretch and Spectral Mixing .....	194
<i>Yuanli Yue, Shouju Liu, Chao Wang, Yanrong Zhai</i>	
Real-Time RF Sensor Monitoring Based on Optical Injected Semiconductor Laser and Temporal Measurement .....	197
<i>Shuo Li, Ailing Zhang, Honggang Pan, Radu-Florin Stancu, Zhongwei Tan, Chao Wang</i>	
Broadband Microwave Frequency Measurement Using a Heterogeneous Multicore Fiber .....	200
<i>Elham Nazemosadat, Sergi García, Ivana Gasulla</i>	
Phase-Stable Broadband Remote Receiving System Based on a Dithered Sample Clock .....	204
<i>Kai Wang, Wei Wei, Pengyu Wang, Chengao Ma, Weilin Xie, Yi Dong</i>	
Microwave Photonic Sensor Based on Optical Sideband Processing with Linear Frequency-Modulated Pulse .....	208
<i>Xiaoyi Tian, Liwei Li, Linh Nguyen, Robert Minasian, Xiaoke Yi</i>	

#### **Author Index**