

2017 INTERNATIONAL IMAGE SENSOR WORKSHOP

Grand Prince Hotel Hiroshima
May 30th - June 2nd, 2017 Hiroshima, Japan

PROGRAM

Tuesday, May 30th 2017

08:00-08:30 Registration

Welcome

08:30-08:45 Opening

Session 01 Stacked Image Sensors

Session chair: Yusuke Oike (Sony)

Dun-Nien Yaung (TSMC)

08:45-09:00 **An Advanced CuCu Hybrid Bonding For Novel Stacked CMOS Image Sensor**

R01

Y. Kagawa¹, N. Fujii², K. Aoyagi², Y. Kobayashi¹, S. Nishi¹, N. Todaka¹, S. Takeshita¹, J. Taura¹, H. Takahashi², Y. Nishimura², K. Tatani², M. Kawamura¹, H. Nakayama¹, T. Nagano², K. Ohno², H. Iwamoto², S. Kadomura¹, T. Hirayama². ¹ Sony Semiconductor Manufacturing, Japan; ² Sony Semiconductor Solutions, Japan

09:00-09:15 **A 3D Stacked Programmable Image Processing Engine in a 40nm Logic Process with a Detector Array in a 45nm CMOS Image Sensor Technologies**

R02

Biay - Cheng Hseih¹, Keith Honea¹, Sami Khawam¹, Sergio Goma¹, RJ Lin², Chin - Hao Chang², Charles Liu², Shang - Fu Yeh², Hong - Yi Tu², Kuo - Yu Chou², Calvin Chao². ¹ Qualcomm Technologies Inc., USA; ² TSMC, Taiwan, ROC

09:15-09:30 **1.0um Pixel Improvements with Hybrid Bond Stacking Technology**

R03

V.C. Venezia, C. Shih, W.Z. Yang, Y. Zang, Z. Lin, Lindsay Grant, and Howard Rhodes. Omnivision Technologies, USA

09:30-09:45 **Vertically Integrated Edgeless Photon Imaging Camera**

R04

Farah Fahim, Grzegorz Deptuch, Alpana Shenai, Piotr Maj, Piotr Kmon, Pawel Grybos, Robert Szczygiel, D. Peter Siddons, Abdul Rumaiz, Anthony Kuczewski, Joseph Mead, Rebecca Bradford, John Weizeorick . Fermi National Laboratory, USA

09:45-10:00 **Low Dark Current and Low Noise 0.9 μm Pixel in a 45 nm Stacked CMOS Image Sensor Process Technology**

R05

Seiji Takahashi, Yi-Min Huang, Jhy-Jyi Sze, Tung-Ting Wu, Fu-Sheng Guo, Wei-Cheng Hsu, Tung-Hsiung Tseng, Chia-Ching Liao, Chin-Chia Kuo, Tzu-Hsiang Chen, Wei-Chieh Chiang, Chun-Hao Chuang, Keng-Yu Chou, Chi-Hsien Chung, Kuo-Yu Chou, Chien-Hsien Tseng, Chuan-Joung Wang and Dun-Nien Yaung. Taiwan Semiconductor Manufacturing Company, Taiwan, ROC

10:00-10:15 **A Survey of Enabling Technologies in Successful Consumer Digital Imaging**

R06 *Ray Fontaine. TechInsights, Inc., Canada*

10:15-10:40 **Break**

Session 02 Noise

Session chair: Boyd Fowler (OmniVision Technologies)

Hidekazu Takahashi (Canon)

10:40-10:55 **Dark Current Limiting Mechanisms in CMOS Image Sensors**

R07 *Dan McGrath¹, Steve Tobin¹, Vincent Goiffon², Marius Sergent², Pierre Magnan².
¹BAE Systems, USA; ISAE-SUPAERO, Université de Toulouse, France*

10:55-11:10 **Development of Low Noise Memory Node in a 2.8 μ m Global Shutter Pixel with Dual Transfer**

R08 *Masafumi Tsutsui¹, Tatsuya Hirata¹, Keishi Tachikawa¹, Ikuo Mizuno¹,
Masakatsu Suzuki¹, Dmitry Veinger², Adi Birman² & Assaf Lahav². ¹Towerjazz
Panasonic Semiconductor Co. Ltd., Japan; ²TowerJazz, Migdal Haemek, Israel*

11:10-11:25 **Temporal Noise Improvement Using the Selective Application of the Fluorine Implantation in the CMOS Image Sensor**

R09 *Man-Lyun Ha, Min-Kyu Kang, Sang-Won Yoon, Chang-Hoon Han, Juil Lee, and
Yoon-Jong Lee. Dongbu HiTek, Korea*

11:25-11:40 **Random Telegraph Noise Pixel Classification and Time Constant Extraction for a 1.1 μ m 8.3MP CMOS Image Sensor**

R10 *Calvin Chao, Honyih Tu, Thomas Wu, Kuo-Yu Chou, Shang-Fu Yeh, and
Fu-Lung Hsueh. Taiwan Semiconductor Manufacturing Company, Taiwan, ROC*

11:40-11:55 **Statistical Analysis of Random Telegraph Noise in Source Follower Transistors with Various Shapes**

R11 *Shinya Ichino¹, Takezo Mawaki¹, Shunichi Wakashima¹, Akinobu Teramoto²,
Rihito Kuroda¹, Phillipe Gaubert², Tetsuya Goto², Tomoyuki Suwa² and
Shigetoshi Sugawa^{1,2}. ¹Graduate School of Engineering, Tohoku University, Japan;
²New Industry Creation Hatchery Center, Tohoku University, Japan*

11:55-12:10 **Impact of Random Telegraph Noise with Various Time Constants and Number of States in CMOS Image Sensors**

R12 *Rihito Kuroda¹, Akinobu Teramoto² and Shigetoshi Sugawa^{1,2}. ¹Graduate School of
Engineering, Tohoku University, Japan; ²New Industry Creation Hatchery Center,
Tohoku University, Japan*

12:10-13:45 **Lunch**

Session 03 Image Sensor Optics

Session chair: Bumsuk Kim (Samsung)

13:45-14:00 A Spectral Imaging System with an Over 70dB SNR CMOS Image Sensor and Electrically Tunable 10nm FWHM Multi-Bandpass Filter

R13 *Yasuyuki Fujihara¹, Yusuke Aoyagi¹, Satoshi Nasuno¹, Shunichi Wakashima¹, Rihito Kuroda¹, Kohei Terashima¹, Takahiro Ishinabe¹, Hideo Fujikake¹, Kazuhiro Wako², Shigetoshi Sugawa¹. ¹ Tohoku University, Japan; ² National Institute of Technology, Sendai College, Japan*

14:00-14:15 A Study on “On Chip Hybrid IRC Technology” to Provide a Thinner Solution for CIS

R14 *Li-Kai Lee¹, Chih-Chieh Chang¹, Yu-Kun Hsiao¹, JC_Hsieh¹, Kazuaki Hashimoto², Chien-Hsien Tseng², Chun-Hao Chuang², Wei-Chieh Chiang². ¹ VisEra Technologies Company, Taiwan; ² Taiwan Semiconductor Manufacturing Company, Taiwan*

14:15-14:30 Quantum Efficiency Simulation with Boltzmann Transport Equation for Motion Modeling of Individual Particles in Photodiodes

R15 *Yuichiro Yamashita⁴, Natsumi Minamitani¹, Masayuki Uchiyama², Yoshinari Kamakura¹ and Dun-Nian Yaung³. ¹ Osaka University, Japan; ² CIS Product Development Section-1, Taiwan Semiconductor Manufacturing Company, Ltd., Taiwan; ³ CMOS Image Sensor Division, Taiwan Semiconductor Manufacturing Company, Ltd., Taiwan; ⁴ CIS Sensing System Technology, Taiwan Semiconductor Manufacturing Company, Ltd., Taiwan*

14:30-14:45 Nanostructured Metallic Color Filter for Wide-Range and Multi-Band Image Sensor

R16 *Atsushi Ono¹, Atsutaka Miyamichi², Hiroki Kamehama², Keiichiro Kagawa¹, Keita Yasutomi¹, and Shoji Kawahito¹. ¹ Research Institute of Electronics, Shizuoka University, Japan; ² Graduate School of Integrated Science and Technology, Shizuoka University, Japan*

14:45-15:00 Lens Solution for Intensity Enhancement in Large-Pixel Single-Photon Avalanche Diode

R17 *Sheng-Chuan Cheng, Chih-Ching Chang, Kuo-Feng Lin, Chien-Hsiung Huang, Lin-Ya Tseng, Hui-Min Yang, Ken Wu, JC Hsieh. VisEra Technologies Company, Taiwan*

15:00-15:25 Break

Session 04 Poster Presentations

15:25-17:48 Session chair: Vladimir Koifman (Analog Value)

Jun Ohta (Nara Institute of Science and Technology)

- P01 **A Proposal of PUF Utilizing Pixel Variations in a CMOS Image Sensor**
Shunsuke Okura¹, Yuki Nakura², Masayoshi Shirahata³, Mitsuru Shiozaki³, Takaya Kubota³, Kenichiro Ishikawa¹, Isao Takayanagi¹, and Takashi Fujino⁴.
¹ Brillnics Japan Inc., Japan; ² Graduate School of Science and Technology Ritsumeikan University, Japan; ³ Department of Science and Engineering Ritsumeikan University, Japan; ⁴ Research Organization of Science and Engineering Ritsumeikan University, Japan
- P02 **A Miniature Imaging Device Using a Self-Reset Image Sensor for Hemodynamic Imaging**
K. Sasagawa, M. Haruta, T. Yamaguchi, Y. Ohta, T. Noda, T. Tokuda, and J. Ohta.
Nara Institute of Science and Technology, Japan
- P03 **CMOS Terahertz Imaging Pixel With a Small On-Chip Antenna**
Shota Hiramatsu, Kosuke Wakita, Eiichi Sano, Seokjin Na, Sayuri Yokoyama, and Masayuki Ikebe. *Hokkaido University, Japan*
- P04 **Investigations on Cryogenic Operation of Pinned Photodiode Pixels**
Philippe Martin-Gonthierr, Pierre Magnan, Olivier Marcelot. *ISAE-SUPAERO, Université de Toulouse, France*
- P05 **Differential Digital Double Sampling Readout Scheme for a 4T 4-Shared Pixel with Reduced Interconnection**
Jeroen Rotte¹, Peter Centen¹, Juul van den Heijkant¹, Adi Birman², Dmitry Veinger². *¹ Grass Valley, The Netherlands; ² TowerJazz, Israel*
- P06 **Column-Parallel Dynamic TDC Reallocation in SPAD Sensor Module Fabricated in 180nm CMOS for Near Infrared Optical Tomography**
Scott Lindner^{1,2}, Chao Zhang³, Ivan Michel Antolovic³, Juan Mata Pavia^{1,2}, Martin Wolf², Edoardo Charbon^{1,3}. *¹ EPFL, Switzerland; ² University Hospital Zurich, Switzerland; ³ TUDelft, The Netherlands*
- P07 **Extending the Dynamic Range of Oversampled Binary SPAD Image Sensors**
Neale A.W. Dutton¹, Tarek Al Abbas², Istvan Gyongy², Robert K. Henderson².
¹ STMicroelectronics, UK; ² The University of Edinburgh, UK
- P09 **Recent Enhancements to Electron Multiplying CCD Image Sensors**
Eric G. Stevens, J. Clayhold, H. Doan, R. Fabinski, J. Hyneczek, S. Kosman, and C. Parks. *ON Semiconductor, USA*

- P10 **8.25 μ m Pitch 66% Fill Factor Global Shared Well SPAD Image Sensor in 40nm CMOS FSI Technology**
T. Al Abbas¹, N.A.W. Dutton², O. Almer¹, S. Pellegrini², B. Rae², D. Golanski³, and R.K. Henderson¹. ¹ The University of Edinburgh, UK; ² STMicroelectronics, UK; ³ STMicroelectronics, France
- P11 **Two-Tier Geiger-Mode Avalanche Detector for Charged Particle Imaging**
Lucio Pancheri¹, Andrea Ficorella¹, Paolo Brogi^{2,3}, Gianmaria Collazuol⁴, Gian-Franco Dalla Betta¹, Pier Simone Marrocchesi^{2,3}, Fabio Morsani³, Lodovico Ratti⁵, Aurore Savoy-Navarro⁶. ¹ DII, Università di Trento and TIFPA-INFN, Italy; ² DFSTA, Università di Siena, Italy; ³ NFN Sezione di Pisa, Italy; ⁴ DFA, Università di Padova, and INFN Sezione di Padova, Italy; ⁵ DIII, Università di Pavia, and INFN Sezione di Pavia, Italy; ⁶ Laboratoire APC, University Paris-Diderot/CNRS, France
- P12 **HAS3: A Radiation Tolerant CMOS Image Sensor for Space Applications**
Manuel Innocent, Thomas Cools, Carl Luybaert, Cedric Esquenet, Wiet Vroom, Ishwar Chandra Mudegowdar, Ioannis Thanasopoulos, Patrick Pintens, Joost Decupere, Tomas Geurts. ON Semiconductor, Belgium
- P13 **Fully Depleted, Monolithic Pinned Photodiode CMOS Image Sensor Using Reverse Substrate Bias**
Konstantin D. Stefanov, Andrew S. Clarke, James Ivory and Andrew D. Holland. The Open University, UK
- P14 **Ultrafast Signal Processing Readout Front-End Electronics in CMOS 40 nm Technology for Hybrid Pixel Detectors Operating in Single Photon Counting Mode.**
Rafal Kleczek, Pawel Grybos, Robert Szczygiel. AGH University of Science and Technology, Poland
- P15 **An Imager with Five 20000 x 15 Pixel TDI CCDs for Photogrammetry Applications**
Jan Bosiers, Erik-Jan Manoury, Harry van Kuijk, Wilco Klaassens, Holger Stoldt, René Leenen, Herman Peek, Walter de Laat. Teledyne DALSA Professional Imaging, The Netherlands
- P16 **Charge-Coupled CMOS TDI Imager**
Hyun Jung Lee, David Atos, Paul Donegan, Feng-Hua Feng, Eric Fox, Roula Ghannoum, Jason Guan, Tihomir Hodalin, Laurens Korthout, Willy Maes, David Marchesan, Brad Moon, Matt Moser, Mark Ruiter, Tsung-Hsun Tsai. Teledyne DALSA Inc., Canada
- P17 **Design and Characterization of a 3.5 μ m Pitch, 8192 Resolution, 5 Spectrum CMOS TDI Image Sensor**
Xinyang Wang, Cheng Ma, Lanlan Liu, Quan Zhou, Yang Li. Gpixel Inc., China

- P18 **A 7-band CCD-in-CMOS Multispectral TDI Imager**
*David San Segundo Bello¹, Maarten De Bock¹, Pierre Boulenc¹,
Roeland Vandebriel¹, Linkun Wu^{1,2}, Jan Van Olmen¹, Vezio Malandruculo¹,
Jan Craninckx¹, Luc Haspeslagh¹, Stefano Guerrieri¹, Maarten Rosmeulen¹,
Jonathan Borremans¹. ¹ imec, Belgium; ² Vrije Universiteit Brussel, Belgium*
- P19 **A 1 x 16 SiPM Array for Automotive 3D Imaging LiDAR Systems**
Salvatore Gnechi, Carl Jackson. SensL Technologies, Ireland
- P20 **A 320x240 10um CAPD ToF Image Sensor with Improved Performance**
*Ward van der Tempel, Alper Ercan, Thomas Finateu, Korina Fotopoulou,
Christian Mourad, Florentina Agavriloaie, Sebastien Resimont, Luca Cutrignelli,
Peter Thury, Camilo Ernesto Medina, Sa Xiao, Jean-Luc Loheac, Jernej Perhac,
Tomas Van de Hauwe, Victor Belokonskiy, Luc Bossuyt, Wouter Aerts, Marc
Pauwels, Daniel Van Nieuwenhove. Softkinetic, Belgium*
- P21 **Simulating the Performance Required for Multi-Tap Charge Modulation Pixels in Time-Resolved Biomedical Imaging**
*Keiichiro Kagawa^{1,2}, Nobukazu Teranishi^{1,3}, Keita Yasutomi¹, Rolf Saager²,
Min-Woong Seo¹, and Shoji Kawahito¹, Anthony Durkin², and Bruce Tromberg².
¹ Shizuoka University, Japan; ² Beckman Laser Institute, UC Irvine, USA;
³ University of Hyogo, Japan*
- 16:25-16:45 **Break**
- P22 **Transfer-Gate Region Optimization and Pinned-Photodiode Shaping for High-Speed TOF Applications**
*Fabio Acerbi¹, Manuel Moreno Garcia¹, Gözen Köklü², Bernhard Buttgen²,
Radoslaw Gancarz², Alice Biber², Daniel Furrer², David Stoppa¹. ¹ Fondazione
Bruno Kessler, Center for Material and Microsystems, Italy; ² Heptagon Advanced
Micro Optics Pte Ltd., Switzerland*
- P24 **Event-Driven Correlated Double Sampling for Pulse-Frequency-Modulation A/D Converters Integrated in Pixel-Parallel Image Sensors**
*Masahide Goto¹, Yuki Honda¹, Toshihisa Watabe¹, Kei Hagiwara¹,
Masakazu Nanba¹, Yoshinori Iguchi¹, Takuya Saraya², Masaharu Kobayashi²,
Eiji Higurashi², Hiroshi Toshiyoshi², and Toshiro Hiramoto². ¹ NHK Science and
Technology Research Laboratories, Japan; ² The University of Tokyo, Japan*
- P25 **Image Sensor With Multiple Sub-radix-2 SAR ADC Calibration and Residual Column Pattern Noise Correction**
*Daniel Van Blerkom, Steve Huang, Barmak Mansoorian. Forza Silicon Corporation,
USA*

- P26 **A High-Speed Imager with Low-Power PTC-Inspired Column-Multiplexed Readout**
Maarten De Bock, Mingxu Liu, Peter Van Wesemael, Annachiara Spagnolo, Jan Craninckx, Koen De Munck, Celso Cavaco, Luc Haspeslagh, Stefano Guerrieri, Maarten Rosmeulen, Jonathan Borremans. imec, Belgium
- P27 **A Small Pixel High Performance Full Frame HDR Sensor**
Salman Kabir, Michael Guidash, Thomas Vogelsang, Craig Smith, Alex Schneider, Jay Endsley. Rambus Inc., USA
- P28 **QLOG - Logarithmic Pixel with Single Electron Detection Capability**
Yang Ni. New Imaging Technologies, France
- P29 **Back Side Illuminated High Dynamic Range 3.0 μ m Pixel Featuring Vertical p-n Junction Capacitance in A Deep Pinned Photodiode**
K. Mori, S.Okura, T. Hasegawa, S. Tanaka and I.Takayanagi. Brillnics Japan Inc., Japan
- P30 **How to Hand-Calculate MTF in Front-Side and Backside Illuminated Image Sensors**
Bart Dierickx¹, Jean Bourgain², Bert Luyssaert¹. ¹ Caeleste, Belgium; ² Institute for Advanced Study, USA
- P31 **A Study on Photon Effect to Image Plane**
Kangbong Seo, Sungryong Lee, Peter Ahn, Dohwan Kim and Kwangbo Cho. SK Hynix semiconductor Inc., Korea
- P32 **PD Barrier Induced Lag Characterization Using a New Lag versus Idle Time Methodology**
W. Gao, N. Li, M. Guidash, R. Ispasoiu, P. R. Ailuri, N. Palaniappan, D. Tekleab, M. Rahman. ON Semiconductor, USA
- P33 **A CMOS Front-end for GaN-based UV Imaging**
Preethi Padmanabhan¹, Bruce Hancock², Shouleh Nikzad², L. Douglas Bell², Kees Kroep³, Edoardo Charbon^{1,3}. ¹ AQUA Laboratory, EPFL, Switzerland; ² Jet Propulsion Laboratory, California Institute of Technology, USA; ³ AQUA Laboratory, TU Delft, The Netherlands
- P34 **Ultraviolet and Visible Spectral Imaging of Hydrogen Flames Using an Organic Photoconductive Film CMOS Imager**
T. Okino, S. Yamahira, S. Yamada, Y. Hirose, A. Odagawa, Y. Kato and T. Tanaka. Panasonic Corporation, Japan

- P35 **Low Dark Current UV-VIS Planar- electrode Perovskite CMOS Image Sensor**
Yan-Rung Lin¹, Pei-Wen Yen¹, Sheng-Min Yu², Shiu-Cheng Lou¹, Kai-Ping Chuang¹, Bor-Nian Chuang¹, Yen-Chih Chiou³, Chih-Cheng Hsieh³, Cheng-Hung Hou⁴, Feng-Yu Tsai⁴. Industrial Technology Research Institute, ¹ Center for Measurement Standards, ² Material and Chemical Research Laboratories, Taiwan; ³ National Tsing Hua University, Taiwan; ⁴ National Taiwan University, Taiwan
- P38 **A 5 Million fps Global Shutter Megapixel Sensor with Shutter Efficiency in Excess of 120 dB**
K. Taylor², W. Chan², A. Birman³, A. Lahav³, A. Fenigstein³, B. Marsh¹, S. Benhammadi¹, R. Turchetta⁴. ¹ STFC Rutherford Appleton Laboratory, UK; ² Specialised Imaging, UK; ³ TowerJazz Semiconductor Ltd., Israel; ⁴ WegaPixel SL, Spain
- P39 **A 10 μm pitch, SXGA Multifunctional IRFPA ROIC with In-Pixel Laser Event Detection and High Dynamic Range Imaging**
C.G. Jakobson, I. Pivnik, R. Dobromislin, G. Zohar, O. Cohen, Y. Chaham, N. Shiloah, R. Talmor, E. Ilan, I. Nevo, W. Freiman, N. Ben Ari, R. Fruhi, T. Shapira, R. Fraenkel. SCD Semiconductor Devices, Israel
- P40 **A 78.3 μV rms Read Noise CMOS Image Sensor with SF Noise Reduction Technique Using Noise-Coupled Amplifier**
Chanmin Park¹, Injun Park¹, Woo Jin Jo¹, Jimin Cheon² and Youngcheol Chae¹. ¹ Yonsei University, Korea; ² Kumoh National Institute of Technology, Korea
- P41 **A New Radiation Hardened CMOS Image Sensor for Nuclear Plant**
T. Watanabe¹, T. Takeuchi², O. Ozawa³, H. Komanome³, T. Akahori¹, K. Tsuchiya². ¹ Brookman Technology, Inc., Japan; ² Japan Atomic Energy Agency, Japan; ³ Ikegami Tsushinki Co., Ltd., Japan
- P42 **Optical Characteristics of Multi-Storied Photodiode CMOS Image Sensor with 3D Stacking Technology**
Y. Takemoto, K. Kobayashi, M. Tsukimura, N. Takazawa, H. Kato, S. Suzuki, J. Aoki, T. Kondo, H. Saito, Y. Gomi, S. Matsuda, and Y. Tadaki. Olympus Corporation, Japan
- P43 **Development of Vertical Thin Poly-Si Channel Structured TG for 3D CIS Pixel Applications**
Young-Jun Kwon¹, Sung-Kun Park¹, Sung-Wook Cho¹, Kyoung-In Lee¹, Sung-Man Kim¹, Chris Hong¹, In-Wook Cho¹, Jae-Hyun Park², and Kyung-Dong Yoo². ¹ SK Hynix, Korea; ² Hanyang University, Korea

P44 **Three-Transistor-Pixel CMOS Image Sensor for 8K Super Hi-Vision Stacked Sensor with Highly Sensitive Photoconversion Layer**
T. Watabe¹, Y. Honda¹, M. Nanba¹, T. Iida², T. Kosugi², H. Ohtake¹, and M. Kubota¹. ¹ NHK Science and Technology Research Laboratories, Japan; ² Brookman Technology, Inc., Japan

P45 **Fresnel Zone Plates : Plasmonics Filtering for SPADS Sensors**
Flavien Hirigoyen. STMicroelectronics, France

17:48- Poster Viewing

Wednesday, May 31st 2017

Session 05 Photon Counting and Photon-based Imaging
Session chair: Bart Dierickx (Caeleste)
Neal Dutton (ST Microelectronics)

08:30-08:45 **Experimental Comparison of MOSFET and JFET 1.1 μm Pitch Jots in 1Mjot Stacked BSI Quanta Image Sensors**

R18 *Jiaju Ma¹, Saleh Masoodian¹, Tzu-Jui Wang² and Eric R. Fossum¹. ¹ Thayer School of Engineering at Dartmouth College, USA; ² Taiwan Semiconductor Manufacturing Company, Taiwan*

08:45-09:00 **A 1Mjot 1000fps 0.22e-rms Stacked BSI Quanta Image Sensor with Cluster - Parallel Readout**

R19 *Saleh Masoodian¹, Jiaju Ma¹, Dakota Starkey¹, Yuichiro Yamashita², and Eric R. Fossum¹. ¹ Thayer School of Engineering, Dartmouth College, USA; ² Taiwan Semiconductor Manufacturing Company (TSMC), Taiwan*

09:00-09:15 **A 512 \times 512 SPAD Image Sensor with Built-In Gating for Phasor Based Real-Time siFLIM**

R20 *Arin Can Ulku¹, Claudio Bruschini¹, Xavier Michalet², Shimon Weiss², Edoardo Charbon¹. ¹ AQUA laboratory, EPFL, Switzerland; ² Department of Chemistry and Biochemistry, UCLA, USA*

09:15-09:30 **3 μm Pitch, 1 μm Active Diameter SPAD Arrays in 130nm CMOS Imaging Technology**

R21 *Ziyang You¹, Luca Parmesan^{1*}, Sara Pellegrini², Robert K. Henderson¹. ¹ The University of Edinburgh, UK; ² STMicroelectronics, UK; * now with Fondazione Bruno Kessler, Italy*

09:30-09:45 **Object Tracking and Reconstruction with a Quanta Image Sensor**

R22 *Istvan Gyongy¹, Tarek Al Abbas¹, Neale A.W. Dutton², Robert K. Henderson¹. ¹ The University of Edinburgh, U.K.; ² STMicroelectronics, U.K.*

09:45-10:00 **A Flexible 32x32 Dual-Side Single-Photon Image Sensor**

R23 *P. Sun, J. Weng, R. Ishihara and E. Charbon. Delft University of Technology, The Netherlands*

10:00-10:25 **Break**

Session 06 Invited Presentation and Range Imaging

Session chair: David Stoppa (Fondazione Bruno Kessler)
Gennadiy Agranov (Apple)

10:25-10:55 **Invited Presentation-I**

I1 **Sensors for future AR/VR applications**

Chiao Liu (Oculus VR Research, Facebook Inc.)

10:55-11:10 **A High-Resolution Time-of-Flight Range Image Sensor with a 3-Tap Lateral Electric Field Charge Modulator**

R24 *Keita Yasutomi, Shoma Imanishi, Yuki Morikawa, Taishi Takasawa, Keiichiro Kagawa, Shoji Kawahito. Shizuoka University, Japan*

11:10-11:25 **Mutually Coupled Ring Oscillators for Large Array Time-of-Flight Imagers**

R25 *Augusto Ronchini Ximenes¹, Preethi Padmanabhan², and Edoardo Charbon^{1,2}.
¹ Delft University of Technology, The Netherlands; ² AQUA Laboratory, EPFL, Switzerland*

11:25-11:40 **3D Imaging with CMOS Single-Photon Detector Arrays for Space Applications: Ground-Based Measurements and Irradiation Tests**

R26 *Matteo Perenzoni¹, Daniele Perenzoni¹, David Stoppa¹, Alexandre Pollini², Jacques Haesler², Christophe Pache². ¹ Fondazione Bruno Kessler, Italy; ² CSEM, Neuchatel, Switzerland*

11:40-11:55 **Indirect ToF Pixel Integrating Fast Buried-Channel Transfer Gates and Gradual Epitaxy, and Enabling CDS**

R27 *Boris RODRIGUES^{1,3}, Marie GUILLON², Nicolas BILLON-PIERON², Jean-Baptiste MANCINI², Olivier SAXOD², Benoit GIFFARD², Yvon CAZAUX², Pierre MALINGE³, Patrice WALTZ³, Auguste NGOUA³, Yannick KERLEGUER³, Alisée TALUY³, Sarah KUSTER³, Sylvain JOBLOT³, François ROY³, Guo-Neng LU¹. ¹ Institut des Nanotechnologies de Lyon, France; ² Univ. Grenoble Alpes, France; ³ STMicroelectronics, France*

11:55-12:10 **A Low-Power Low-Cost High-Speed 2D/3D Camera for Virtual Reality Headsets, Mobile Devices and Automobiles**

R28 *Yibing M. Wang^{1,3}, Iliia Ovsianikov^{1,3}, Jang-Woo You³, Peter Deane², Dirk Smits², Yong-Hwa Park^{3*}, Maarten Niesten², Sungwoo Hwang³, Chilhee Chung³. ¹ Samsung Semiconductor, Inc., USA; ² Samsung Strategy and Innovation Center, USA; ³ Samsung Advanced Institute of Technology, Korea; * Now with KAIST*

12:10-13:45 **Lunch**

Session 07 High Dynamic Range

Session chair: Johannes Solhusvik (OmniVision Technologies)
Orly Yadid-Pecht (University of Calgary)

13:45-14:00 A 87dB Single Exposure Dynamic Range CMOS Image Sensor with a 3.0um Triple Conversion Gain Pixel

R29 *N. Yoshimura, K. Mori, S. Tanaka, T. Hasegawa, S. Matsuo, H. Abe, N. Yasuda, N. Ishikawa, S. Okura, S. Ohsawa, T. Otaka, I. Takayanagi. Brillnics Japan Inc., Japan*

14:00-14:15 A Native HDR 115dB 3.2µm BSI Pixel Using Electrons and Holes Collection

R30 *F. Lalanne, P. Malinge, D. Hérault, C. Jamin. ST Microelectronics, France*

14:15-14:30 A 98dB Linear Dynamic Range, High Speed CMOS Image Sensor

R31 *Tomas Geurts, Bart Cremers, Manuel Innocent, Wiet Vroom, Cedric Esquenet, Thomas Cools, John Compiet, Burak Okcan, Genis Chapinal, Carl Luypaert, Patrick Pintens, Roel Aerts. ON Semiconductor, Belgium*

14:30-14:45 A Method to Increase DR Using Column-Level Automatic Gain Selection

R32 *Gaozhan Cai¹, Wei Wang¹, B.Luyssaert¹, B.Dierickx¹, G.Ruttens¹, J.Basteleus¹, J.De Vroe¹, W.Verbruggen¹, D. Uwaerts¹, B. Uwaerts¹, Peng.Gao¹, Denvir Donal², Philip Steen². ¹ Caeleste, Belgium; ² Andor Technology Ltd., UK*

14:45-15:00 A 0.5e⁻_{rms} Temporal-Noise CMOS Image Sensor with Charge-Domain CDS and Period-Controlled Variable Conversion Gain

R33 *Xiaoliang Ge¹, Albert Theuwissen^{1,2}. ¹ Delft University of Technology, the Netherlands; ² Harvest Imaging, Belgium*

15:00-15:15 140dB Sub-electron Noise Floor Image Sensor

R34 *Sergey Velichko¹, Scott Johnson¹, Dan Pates¹, Chris Silsby², Cornelis Hoekstra², Ray Mentzer², Jeff Beck². ¹ ON Semiconductor, ID, USA; ² ON Semiconductor, OR, USA*

15:15-15:30 A 1392x976 2.8µm 120dB CIS with Per-Pixel Controlled Conversion Gain

R35 *Johannes Solhusvik¹, Ming-Hsuan Hsu², Sam Hu², Robert Johansson¹, Zhiqiang Lin², Siguang Ma², Keiji Mabuchi², Sohei Manabe², Duli Mao², Bill Phan², Howard Rhodes², Charles Shan², Eric Webster², and Trygve Willassen¹. ¹ OmniVision Technologies, Norway; ² OmniVision Technologies, USA*

15:30-15:55 Break

Session 08 Invited Presentation and High Speed

Session chair: Shigetoshi Sugawa (Tohoku University)
Michael Guidash (Rmguidash-consulting)

15:55-16:25 Invited Presentation-II**I2 Extreme Imaging and Beyond**

Keisuke Goda (The University of Tokyo)

16:25-16:40 The Temporal Resolution Limit of the Silicon Image Sensors

R36 *Takeharu Goji Etoh^{1,2}, Anh Quang Nguyen², Yoshinari Kamakura¹, Kazuhiro Shimonomura², Yen Le Thi¹ and Nobuya Mori¹.¹ Osaka University, Japan; ² Ritsumeikan University, Japan*

16:40-16:55 10Mfps 960 Frames Video Capturing Using a UHS Global Shutter CMOS Image Sensor with High Density Analog Memories

R37 *Manabu Suzuki¹, Masashi Suzuki¹, Rihito Kuroda¹, Yuki Kumagai², Akira Chiba², Noriyuki Miura², Naoya Kuriyama² and Shigetoshi Sugawa¹.¹ Tohoku University, Japan; ² LAPIS Semiconductor Miyagi Co., Ltd., Japan*

16:55-17:10 In-Pixel Storage Techniques for CMOS Burst-Mode Ultra-High-Speed Imagers

R38 *L. Wu^{1,2}, D. San Segundo Bello², P. Coppejans², A. Suess², M. Rosmeulen², J. Craninckx², P. Wambacq^{1,2}, J. Borremans².¹ Vrije Universiteit Brussel, Belgium; ² imec, Belgium*

17:10-17:25 A 0.64 microseconds Row-Time CMOS Image Sensor using Gm-Enhanced Repeater Source Follower Buffer and Column Parallel Pipelined ADC

R39 *Toshinori Otaka, Shintaro Maekawa, Hiroyuki Yamaguchi and Takayuki Hamamoto. Tokyo University of Science, Japan*

17:25-17:40 Single Photon Counting Hybrid Pixel Detectors with 85 ns Dead Time, 70 kfps Frame Rate and TSV Option.

R40 *P. Maj¹, Eric Dufresne², P. Grybos¹, K. Kasinski¹, P. Kmon¹, A. Koziol¹, Suresh Narayanan², Alec Sandy², R. Szczygiel¹, Qingteng Zhang².¹ AGH University of Science and Technology, Poland; ² Argonne National Laboratory, USA*

Thursday, June 1st 2017

Session 09 ADC

Session chair: Guy Meynants (AMS)

08:20-08:35 A SAR- $\Delta\Sigma$ ADC with Dynamic Integrator for Low-Noise CMOS Image Sensors

R41 *Akira Matsuzawa, and Masaya Miyahara. Tokyo Institute of Technology, Japan*

- 08:35-08:50 **A 12-bit Column-Parallel Flash TDC-Interpolated Ramp ADC with Online Digital Delay Element Correction**
- R42 *Deyan Levski¹, Martin Wány², Bhaskay Choubey¹. ¹ University of Oxford, UK; ² Austria Microsystems AG., Portugal*
- 08:50-09:05 **A 12-bit, 0.9- μ s Single-Slope ADC for Embedded TDI-CCD and CMOS Line-Scan Image Sensor**
- R43 *Tsung-Hsun Tsai, Paul Donegan, David Atos, Feng-Hua Feng, Eric Fox, Roula Ghannoum, Jason Guan, Tihomir Hodalin, Hyun Jung Lee, Willy Maes, David Marchesan, Brad Moon, Matt Moser, Mark Ruiter, and Laurens Korthout. Teledyne DALSA Inc., Canada*
- 09:05-09:20 **A Highly Linear CMOS Image Sensor with a Digitally Assisted Calibration Method**
- R44 *Fei Wang¹, Liqiang Han², Albert J. P. Theuwissen^{1,3}. ¹ Delft University of Technology, The Netherlands; ² Tianjin University, China; ³ Harvest Imaging, Belgium*
- 09:20-09:35 **A 5-Megapixel 100-Frames-per-second 0.5 μ m Low Noise CMOS Image Sensor With Column-Parallel Two-Stage Oversampled Analog-to-Digital Converter**
- R45 *J. A. Segovia¹, F. Medeiro¹, A. González¹, A. Villegas¹, A. Rodríguez-Vázquez^{1,2}. ¹ AnaFocus e2v, Spain; ² Inst. of Microelectronics of Seville (Univ. de Sevilla & CSIC), Spain*
- 09:35-09:50 **12-bit Column-Parallel Single-Slope ADCs with Operation-Period-Reduced Time-to-Digital Converters for CMOS Image Sensors**
- R46 *Yoshio Hagihara, Yusaku Koyama, Susumu Yamazaki, Takanori Tanaka, Atsuko Kume, Yosuke Kusano, Mai Arita, Masashi Saito, and Yoshihisa Okada. Olympus Corporation, Japan*
- 09:50-10:15 **Break**

<p>Session 10 Invited Presentation and Specialty Image Sensors Session chair: Edoardo Charbon (Delft Univ. of Technology) Pierre Magnan (ISAE)</p>

- 10:15-10:45 **Invited Presentation-III**
- I3 **8K imaging systems and their medical applications**
Kenkichi Tanioka (Medical Imaging Consortium)
- 10:45-11:00 **UV/Optical Photon Counting and Large Format Imaging Detectors from CubeSats, SmallSats to Ultra-large Aperture Space Telescopes & Imaging Spectrometers**
- R47 *Shouleh Nikzad, John J. Hennessy, April D. Jewel, Alex G. Carver, Michael E. Hoenk, Timothy M. Goodsall, Sam Cheng, Erika Hamden, and Todd J. Jones. Jet Propulsion Laboratory, California Institute of Technology, USA*

- 11:00-11:15 **Primal-Dual-Coding CMOS Image Sensor Architecture**
 R48 *Navid Sarhangnejad, Hyunjoong Lee, Nikola Katic, Kyros Kutulakos, Roman Genov. University of Toronto, Canada*
- 11:15-11:30 **A 1ms High-Speed Vision Chip with 3D-Stacked 140GOPS Column-Parallel PEs for Diverse Sensing Applications**
 R49 *Atsushi Nose¹, Tomohiro Yamazaki¹, Hironobu Katayama¹, Shuji Uehara¹, Masatsugu Kobayashi¹, Sayaka Shida¹, Masaki Odahara², Kenichi Takamiya², Yasuaki Hisamatsu², Shizunori Matsumoto², Leo Miyashita³, Yoshihiro Watanabe³, Takashi Izawa¹, Yoshinori Muramatsu¹, Yoshikazu Nitta¹, Masatoshi Ishikawa³. ¹ Sony Semiconductor Solutions, Japan; ² Sony LSI Design, Japan; ³ The University of Tokyo, Japan*
- 11:30-11:45 **High Speed Backside Illuminated TDI CCD-in-CMOS Sensor**
 R50 *Pierre Boulenc¹, Jo Robbelein¹, Linkun Wu^{1,2}, Vasyly Motsnyi¹, Luc Haspeslagh¹, Stefano Guerrieri¹, Jonathan Borremans¹, Maarten Rosmeulen¹. ¹ imec, Belgium; ² Vrije Universiteit Brussel, Belgium*
- 12:30- **Lunch / Social Event**
- 18:30- **Dinner / Award Session**

Friday, June 2nd 2017

Session 11 Invited Presentation and Non-Visible Imaging Session chair: Shouleh Nikzad (Jet Propulsion Laboratory) Vyshnavi Suntharalingam (MIT)
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- 08:30-09:00 **Invited Presentation-IV**
 I4 **Current status of CCDs for astronomical observations and the development of a large mosaic camera**
Satoshi Miyazaki (The National Astronomical Observatory of Japan)
- 09:00-09:15 **Event-Driven Dual-Gain Fully-Depleted SOI Based X-Ray Detector for High Energy Particle Imaging**
 R51 *Sumeet Shrestha¹, Hiroki Kamehama¹, Keita Yasutomi¹, Keiichiro Kagawa¹, Nobukazu Teranishi¹, Ayaki Takeda², Takeshi Go Tsuru², Yasuo Arai³ and Shoji Kawahito¹. ¹ Shizuoka University, Japan; ² Kyoto University, Japan; ³ High Energy Accelerator Research Organization (KEK), Japan*
- 09:15-09:30 **Radiation-hard, Nanosecond-gated CMOS Imaging Detectors**
 R52 *Michael E. Hoenk¹, April D. Jewell¹, Shouleh Nikzad¹, Doug Trotter², Quinn Looker², Gideon Robertson². ¹ Jet Propulsion Laboratory, California Institute of Technology, USA; ² Sandia National Laboratories, USA*

09:30-09:45 **A QuantumFilm Based QuadVGA 1.5 μ m Pixel Image Sensor with Over 40% QE at 940 nm for Active Illumination Applications.**

R53 *Nikolai Bock, Aurelien Bouvier, Dario Clocchiatti, Naveen Kolli, Vitanshu Sharma, Emanuele Mandelli. InVisage Technologies, USA*

09:45-10:00 **Monolithic Near Infrared Image Sensors Enabled by Quantum Dot Photodetector**

R54 *Pawel E. Malinowski¹, Epimitheas Georgitzikis^{1,2}, Jorick Maes^{3,4}, Mehedi Mamun^{1,4}, Oscar Enzing¹, Fortunato Frazzica^{1,5}, Jan Van Olmen¹, Piet De Moor¹, Paul Heremans^{1,2}, Zeger Hens^{3,4}, and David Cheyns¹. ¹IMEC, Belgium; ²KU Leuven, Belgium; ³Physics and Chemistry of Nanostructures, Ghent University, Belgium; ⁴Center for Nano- and Biophotonics, Ghent University, Belgium; ⁵Vrije Universiteit Brussel, Belgium*

10:00-10:15 **Challenges in Improving the Performances of Radiation Hard CMOS Image Sensors for Gigarad (Grad) Total Ionizing Dose**

R55 *Vincent Goiffon¹, Serena Rizzolo¹, Franck Corbière¹, Sébastien Rolando¹, Aziouz Chabane¹, Marius Sergent¹, Philippe Paillet², Sylvain Girard³, Magali Estribeau¹, Pierre Magnan¹, Marco Van Uffelen⁴, Laura Mont Casellas⁴, Marc Gaillardin², Robin Scott⁵ and Wouter De Cock⁶. ¹ISAE-SUPAERO, France; ²CEA, France; ³Université de Saint-Etienne, France; ⁴Fusion for Energy, Spain; ⁵Oxford Technologies Ltd., UK; ⁶SCK-CEN, Belgium*

10:15-10:40 **Break**

Session 12 Global Shutter

Session chair: Eric Stevens (ON Semiconductor) Daniel Van Blerkom (Forza Silicon)
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10:40-10:55 **Cross Talk, Quantum Efficiency and Parasitic Light Sensitivity Comparison for Different Near Infra-Red Enhanced Sub 3 μ m Global Shutter Pixel Architectures**

R56 *Assaf Lahav¹, Dmitry Veinger¹, Adi Birman¹, Masakatsu Suzuki², Tatsuya Hirata², Keishi Tachikawa², Masafumi Tsutsui², Toshifumi Yokoyama², Yoshiaki Nishi² and Ikuo Mizuno². ¹TowerJazz SemiConductors, Israel; ²Towerjazz Panasonic semiconductor Co., Ltd., Japan*

10:55-11:10 **A High Optical Performance 3.4 μ m Pixel Global Shutter CMOS Image Sensor with Light Guide Structure**

R57 *Hiroshi Sekine, Masahiro Kobayashi, Yusuke Onuki, Kazunari Kawabata, Toshiki Tsuboi, Yasushi Matsuno, Hidekazu Takahashi, Shunsuke Inoue, and Takeshi Ichikawa. Canon Inc., Japan*

11:10-11:25 **Design of Double Micro Lens Structure for 2.8 μ m Global Shutter Pixel**

R58 *Toshifumi Yokoyama¹, Masakatsu Suzuki¹, Yoshiaki Nishi¹, Ikuo Mizuno¹ and Assaf Lahav². ¹Towerjazz Panasonic semiconductor Co., Ltd., Japan; ²TowerJazz SemiConductors, Israel*

11:25-11:40 **A Fully-Depleted 52 μm GS CIS Pixel with 6 ns Charge Transfer, 7 e⁻rms Read Noise, 80 $\mu\text{V}/\text{e}^-$ CG and >80 % VIS-QE**

R59 *Andreas Suss¹, Linkun Wu^{2,1}, Jean-Luc Bacq¹, Annachiara Spagnolo¹, Philippe Coppejans¹, Vasyl Motsnyi¹, Luc Haspeslagh¹, Jonathan Borremans¹, Maarten Rosmeulen¹. ¹IMEC, Belgium; ²Vrije Universiteit Brussel, Belgium*

11:40-11:55 **Global Shutter Backside Illumination CMOS Image Sensor for Satellite Navigation**

R60 *David Price¹, Rick Jerome¹, Akihiro Hasegawa¹, Jeff Gambino¹, Rusty Winzenread², Kyle Thomas², Andrew Piner², Michael Wu², Patti Guidash³, Tom Carducci³, Tom Frank³, Bill Desjardin³, Rich Brolly³, Thad Smith⁴, Brandon Riebeek⁴, Eddie Glines⁴, Gerald Heim⁵, Tom Ebben⁵, Rino Marinelli⁶, Onorato Di Cola⁶, Giovanni De Amicis⁶. ¹ON Semiconductor, OR, USA; ²ON Semiconductor, CA, USA; ³ON Semiconductor, NY, USA; ⁴ON Semiconductor, ID, USA; ⁵Ball Aerospace, USA; ⁶LFoundry, Italy*

11:55-12:10 **A 47 MPixel 36.4 x 27.6 mm² 30 fps Global Shutter Image Sensor**

R61 *Guy Meynants, Bram Wolfs, Peishuo Li, Zhisheng Li, Yongjia Li, Ybe Creten, Koen Ruythooren, Raf Lafaille, Pieter De Wit, Pascale Francis, Gerd Beeckman, Jan Martin Kopfer, Jan Bogaerts. AMS, Belgium*

12:10-12:15 **Closing Remarks**