

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, 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, Sami Khawam¹, Nousias Ioannis¹, Mark Muir¹, Khoi Le¹, Keith Honea¹, 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, L. A. Grant, and H. Rhodes. Omnivision Technologies, USA*
- 09:30-09:45 **Vertically Integrated Edgeless Photon Imaging Camera**
R04 *Farah Fahim¹, Grzegorz Deptuch¹, Alpana Shenai¹, Piotr Maj², Piotr Kmon², Pawel Grybos², Robert Szczygiel², D. Peter Siddons³, Abdul Rumaiz³, Anthony Kuczewski³, Joseph Mead³, Rebecca Bradford⁴, John Weizeorick⁴. ¹ Fermi National Accelerator Laboratory, USA; ² AGH-UST, Poland; ³ Brookhaven National Laboratory, USA; ⁴ Argonne 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 Products**

R06 *R. Fontaine. TechInsights, 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, Alexandre Le Roch³. ¹ BAE Systems, USA; ² ISAE-SUPAERO, Université de Toulouse, France; ³ CNES, France*

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

R08 *Masafumi Tsutsui¹, Tatsuya Hirata¹, Keishi Tachikawa¹, Ikuo Mizuno¹, Masakatsu Suzuki¹, Dmitry Veinger², Adi Birman² & Assaf Lahav². ¹ Towerjazz Panasonic Semiconductor Co. Ltd., Japan; ² TowerJazz, 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 1.1µm Pitch 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}. ¹ Graduate School of Engineering, Tohoku University, Japan; ² New 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}. ¹ Graduate School of Engineering, Tohoku University, Japan; ² New 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 and 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 Yamashita¹, Masayuki Uchiyama¹, Dun-Nian Yaung¹, Natsumi Minamitani² and Yoshinari Kamakura². ¹ Taiwan Semiconductor Manufacturing Company, Ltd., Taiwan; ² Osaka University, Japan*

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 the 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**
Kiyotaka Sasagawa, Makito Haruta, Takahiro Yamaguchi, Yasumi Ohta, Toshihiko Noda, Takashi Tokuda, and Jun Ohta. Nara Institute of Science and Technology, Japan
- P03 **CMOS Terahertz Imaging Pixel with a Small On-Chip Antenna**
Shota Hiramatsu¹, Kosuke Wakita¹, Seokjin Na², Sayuri Yokoyama², Masayuki Ikebe² and Eiichi Sano¹.
¹ Research Center for Integrated Quantum Electronics, Hokkaido University, Japan; ² Graduate School of Information Science and Technology, 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 Wolf¹, Edoardo Charbon^{2,3}.
¹ University Hospital Zurich, Switzerland; ² EPFL, 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, F.M. Della Rocca^{1,2}, 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, Paul Donegan, David Atos, Feng-Hua Feng, Eric Fox, Roula Ghannoum, Jason Guan, Willy Maes, David Marchesan, Matt Moser, Nixon O, Mark Ruiter, Tsung-Hsun Tsai, and Laurens Korthout. Teledyne DALSA Inc., Canada
- P17 **Design and Characterization of a 3.5 μ m Pitch, 8192 Resolution, 5 Spectrum CMOS TDI Image Sensor**
Cheng Ma¹, Quan Zhou¹, Lanlan Liu¹, Yang Li¹, Adri Mierop², Agnes Kleimann², Xinyang Wang¹. ¹ Gpixel Inc., China; ² now with X-FAB Semiconductor Foundries AG, Germany

- 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 × 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 Agavriiloaie, 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, Shoji Kawahito¹, Anthony Durkin², and Bruce Tromberg².
¹ Shizuoka University, Japan; ² 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 Büttgen²,
Radoslaw Gancarz², Alice Biber², Daniel Furrer², David Stoppa¹. ¹ Fondazione
Bruno Kessler, 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 CMOS Pixel with Single Electron Detection Capability**
Yang Ni. New Imaging Technologies, France
- P29 **Back Side Illuminated High Dynamic Range 3.0µm 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 **Photodiode Barrier Induced Lag Characterization Using a New Lag versus Idle Time Methodology**
W. Gao, M. Guidash, N. Li, R. Ispasoiu, P. R. Ailuri, N. Palaniappan, D. Tekleab, M. Rahman. ON Semiconductor, CA, 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**
S. Benhammadi¹, B. Marsh¹, K. Taylor², W. Chan², A. Birman³, A. Lahav³, A. Fenigstein³, 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 75.6 μV_{rms} Read Noise CMOS Image Sensor with Pixel Noise Reduction 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, 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 Transfer Gate Structured Pixel for 3D CIS 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**
Toshihisa Watabe, Yuki Honda, Masakazu Nanba, Hiroshi Ohtake, and Misao Kubota. NHK Science and Technology Research Laboratories, 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)
Neale A.W. Dutton (STMicroelectronics)

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 1040fps 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 University of California at Los Angeles, 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 *Pengfei Sun^{1,2}, Junjie Weng¹, Ryoichi Ishihara¹ and Edoardo Charbon¹. ¹ Delft University of Technology, The Netherlands; ² X-FAB Semiconductor Foundries AG, Germany*

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, Michael Hall, Renzo De Nardi, Nicholas Trail, Richard Newcombe. Oculus Research, Facebook Inc., USA

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, Yuki Morikawa, Shoma Imanishi, 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, 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-Pierron², 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 Univ. Claude Bernard Lyon 1, 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}, Ilia 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 **An 87dB Single Exposure Dynamic Range CMOS Image Sensor with a 3.0 μ m Triple Conversion Gain Pixel**

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

14:00-14:15 **A Native HDR 115dB 3.2 μ m BSI Pixel Using Electron and Hole Collection**

R30 *Frédéric Lalanne, Pierre Malinge, Didier Hérault and Clémence Jamin-Mornet. STMicroelectronics, 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 Compriet, Burak Okcan, Genis Chapinal, Carl Luybaert, 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, Bert Luyssaert¹, Bart Dierickx¹, Gerlinde Ruttens¹, Bert Uwaerts¹, Dirk Uwaerts¹, Jente Basteleus¹, Jens De Vroe¹, Walter Verbruggen¹, Peng Gao¹, Donal Denvir², Philip Steen². ¹ Caeleste CVBA, 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 Dynamic Range 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 2.8 μ m 120dB CIS with Per-Pixel Controlled Conversion Gain**

R35 *Johannes Solhusvik¹, 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 (RM Guidash Consulting)

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

Cheng Lei¹, Yasuyuki Ozeki², and Keisuke Goda^{1,3,4}. ¹ Department of Chemistry, University of Tokyo, Japan; ² Department of Electrical Engineering and Information Systems, University of Tokyo, Japan; ³ University of California, Los Angeles, USA; ⁴ Japan Science and Technology Agency, Japan

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

R36 *Takeharu Goji Etoh^{1,2}, Anh Quang Nguyen¹, Yoshinari Kamakura², Kazuhiro Shimonomura¹, Yen Le Thi² and Nobuya Mori². ¹ Ritsumeikan University, Japan; ² Osaka 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. Süß², 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, E. Dufresne², P. Grybos¹, K. Kasinski¹, P. Kmon¹, A. Koziol¹, S. Narayanan², A. Sandy², R. Szczygiel¹, Q. 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 Linearity-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. Medeiro^{1,2}, A. González¹, A. Villegas¹, A. Rodríguez-Vázquez^{1,2}. ¹ Teledyne AnaFocus, 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**

Session 10 Invited Presentation and Specialty Image Sensors

Session chair: Edoardo Charbon (Delft Univ. of Technology)

Pierre Magnan (ISAE)

10:15-10:45 **Invited Presentation-III**

I3 **8K Imaging Systems and Their Medical Applications**
—World's First 8K Rigid Endoscope Camera—

Kenkichi Tanioka, Medical Imaging Consortium, Japan

- 10:45-11:00 **UV/Optical Photon Counting and Large Format Imaging Detectors from CubeSats, SmallSats to Large Aperture Space Telescopes & Imaging Spectrometers**
 R47 *Shouleh Nikzad¹, April D. Jewel¹, Alex G. Carver¹, John J. Hennessy¹, Michael E. Hoenk¹, Sam Cheng¹, Timothy M. Goodsall¹, Gillian Kyne², Erika Hamden², and Todd J. Jones¹. ¹ Jet Propulsion Laboratory, California Institute of Technology, USA; ² California Institute of Technology, USA*
- 11:00-11:15 **CMOS Image Sensor Architecture for Primal-Dual Coding**
 R48 *Navid Sarhangnejad, Hyunjoong Lee, Nikola Katic, Matthew O'Toole, Kiriakos 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, 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 1.5µm Pixel Image Sensor with Over 40% QE at 940 nm for Actively Illuminated Applications.**

R53 *Lionel Barrow, Nikolai Bock, Aurelien Bouvier, Dario Clocchiatti, Jian Feng, Naveen Kolli, Andras Pattantyus, Vitanshu Sharma, Tzi-Hsiung Shu, Emanuele Mandelli. InVisage Technologies, USA*

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

R54 *Pawel E. Malinowski¹, Epimiteas 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. ¹ IMEC, Belgium; ² KU Leuven, Belgium; ³ Physics and Chemistry of Nanostructures, Ghent University, Belgium; ⁴ Center for Nano- and Biophotonics, Ghent University, Belgium; ⁵ Vrije 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. ¹ ISAE-SUPAERO, France; ² CEA DAM-DIF, France; ³ Université de Saint-Etienne, France; ⁴ Fusion for Energy, Spain; ⁵ Oxford Technologies Ltd., UK; ⁶ SCK-CEN, Belgium*

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

Session 12 Global Shutter

Session chair: Eric Stevens (ON Semiconductor)
Daniel Van Blerkom (Forza Silicon)

10:40-10:55 **Cross Talk, Quantum Efficiency, and Parasitic Light Sensitivity Comparison for Different Near Infra-Red Enhanced sub 3µm 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. ¹ TowerJazz Semiconductors, Israel; ² Towerjazz Panasonic semiconductor, Japan*

10:55-11:10 **A High Optical Performance 3.4 µm Pixel Pitch 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. ¹ Towerjazz Panasonic semiconductor Co., Ltd., Japan; ² TowerJazz SemiConductors, Israel*
- 11:25-11:40 **A Fully Depleted 52 μ m GS CIS Pixel with 6 ns Charge Transfer, 7 e⁻_{rms} Read Noise, 80 μ V/e⁻ CG and >80 % VIS-QE**
R59 *Andreas Süss¹, Linkun Wu^{2,1}, Jean-Luc Bacq¹, Annachiara Spagnolo¹, Philippe Coppejans¹, Vasyl Motsnyi¹, Luc Haspeslagh¹, Jonathan Borremans¹, Maarten Rosmeulen¹. ¹ IMEC, Belgium; ² Vrije Universiteit Brussel, Belgium*
- 11:40-11:55 **A 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 Wu³, Patti Guidash⁴, Tom Carducci⁴, Tom Frank⁴, Bill Desjardin⁴, Rich Brolly⁴, Thad Smith⁵, Brandon Riebeek⁵, Eddie Glines⁵, Gerald Heim⁶, Tom Ebben⁶, Rino Marinelli⁷, Onorato Di Cola⁷, Giovanni De Amicis⁷. ¹ ON Semiconductor, OR, USA; ² ON Semiconductor, CA, USA; ³ ON Semiconductor, AZ, USA; ⁴ ON Semiconductor, NY, USA; ⁵ ON Semiconductor, ID, USA; ⁶ Ball Aerospace, USA; ⁷ LFoundry, 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, Jan Bogaerts, Peishuo Li, Zhisheng Li, Yongjia Li, Ybe Creten, Koen Ruythooren, Pascale Francis, Raf Lafaille, Pieter De Wit, Gerd Beeckman, Jan Martin Kopfer. AMS, Belgium*
- 12:10-12:15 **Closing Remarks**