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Quanta Image Sensor (QIS), or, Detecting Single Electrons in Silicon at Room Temperature, Without Avalanche Multiplication, in a Commercial Product

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Abstract: The Quanta Image Sensor (QIS) was conceived as a different image sensor – one that counts photoelectrons one at a time using perhaps a billion, small, specialized pixels, read out at high frame rate, perhaps thousands of frames per second. A gray-scale image (or color image) is created post-capture from the collected data using computation imaging or machine-learning approaches. Over the past 6 or so years, pixels that can count a single electron or resolve electron number directly at room temperature, without avalanche multiplication, have been invented and demonstrated at Dartmouth. A 1-Mpixel QIS device was implemented in the TSMC 65nm/45nm stacked backside-illuminated CMOS image sensor process and demonstrated to function. Soon thereafter, Gigajot Technology Inc was spun off from Dartmouth to further commercialize QIS devices. In this talk, the device concept, device implementation(s), and results will be presented. Recent progress at Dartmouth on improving the devices will be introduced. Product data from Gigajot, that uses the technology developed for QIS for deep-sub-electron read noise, will be also be included, time permitting.

Bio: Dr. Eric R. Fossum is best known for the invention of the CMOS image sensor “camera-on-a-chip” used in billions of cameras. He is a solid-state image sensor device physicist and engineer, and his career has included academic and government research, and entrepreneurial leadership. He is the John H. Krehbiel Sr. Professor for Emerging Technologies at the Dartmouth Engineering, directs the Dartmouth’s Ph.D. Innovation Programs and serves as Dartmouth’s Vice Provost for Entrepreneurship and Technology Transfer. In 2017, Dr. Fossum received the Queen Elizabeth Prize from HRH Prince Charles, considered by many as the Nobel Prize of Engineering “for the creation of digital imaging sensors,” along with three others. He was inducted into the National Inventors Hall of Fame and elected to the National Academy of Engineering. Other honors include the 2020 OSA and IS&T Edwin Land Medal, the IEEE Andrew Grove Medal, the SMPTE Camera Origination and Imaging Medal, and Yale’s Wilbur Cross Medal. He is also the first and only Dartmouth Engineering professor to win an Emmy Award. Dr. Fossum has published over 300 technical papers and holds over 175 US patents. He co-founded several startups and served as CEO. He also co-founded the International Image Sensor Society (IISS) and was its first President. He is a Fellow member of the Institute of Electrical and Electronic Engineers (IEEE) and the Optical Society of America (OSA).