E-newsletter

"MiSPiA"
Microelectronic Single-Photon 3D Imaging Arrays for low-light high-speed Safety and Security Applications

Project reference: 257646
Instrument: STREP

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Timeline
Start Date: 01/06/2010
End Date: 31/05/2013

Bdget
Overall Cost: € 3.400.166
Funding: € 2.632.854

Project Partners
- Politecnico di Milano, IT
- Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung E.V, DE
- Heriot-Watt University, UK
- Micro Photon Devices S.R.L., IT
- Centro Ricerche FIAT SCPA, IT
- EMZA Visual Sense LTD, IL
- CF Consulting Finanziamenti Unione Europea SRL, IT

At the beginning of the project, the **"Requirements, constraints and specifications for the 3D SPAD imagers"** were fully defined for both the 3D ranging imagers, based on direct and indirect Time-of-Flight (TOF) techniques, and the 2D imagers, based on photon counting. The characteristics and specifications of individual SPAD detectors, smart pixels, array chips and full imagers were defined, based on the accurate exploitation of a cost-effective standard CMOS fabrication technology. Furthermore an advanced back-illuminated chip will be conceived and developed to boost imager performance at the top, thanks to an advance wafer bonding processing.

The design of **"Test structures for SPADs, smart-pixels and mini-arrays for 2D imaging**" has been completed in this first year of the project. Various test structures for individual CMOS SPAD detectors have been conceived, designed, fabricated and fully tested. The first two batches in Nov. 2010 and March 2011 allow to properly define the best performing SPAD structure and sensing electronics. These test structures already reached the best performance of state-of-the-art single-photon detectors, in terms of Dark-Counting Rate (lower than 20cps at 5V excess bias for 20µm-diameter SPADs), Photon Detection Efficiency (60% at 400nm and still 10% at 750nm) and Time-of-Flight precision (better than $40ps_{FWHM}$ at just 5V excess bias). The first complete chip out with smart-pixels and fully functional mini-arrays for 2D "photon counting" imaging is going to be released in August 2011.

The first design of **"SPAD smart-pixels and mini-arrays for 3D imaging"** has been completed at the end of the first year. Preliminary experiments of iTOF 3D scene acquisition have been proved by means of simple 1024 pixels SPAD 2D imagers. Different smart-pixels for TOF-based 3D ranging imagers have been proposed and implemented: i) direct dTOF, with in-pixel Time-to-Digital Converter able to provide the round-trip time of flight of each single photon; ii) an indirect iTOF with pulsed excitation of the scene; iii) an indirect iTOF with a sinusoidal-modulated scene illumination. Different light sources (highly efficient LEDs and pulsed lasers) are being tested in the MiSpiA labs for assessing the best candidates for the Safety 3D short-range automotive ranging and the Security 3D long-range applications. In October 2011 the most promising smart-pixels and illuminators will be selected exploited at best for the design of the final smart-pixels and arrays for the Front-illuminated 3D ranging imagers. Instead the Back-illuminated chips will be conceived in the second year of the MiSPiA project.