Press Release - "MiSPiA"

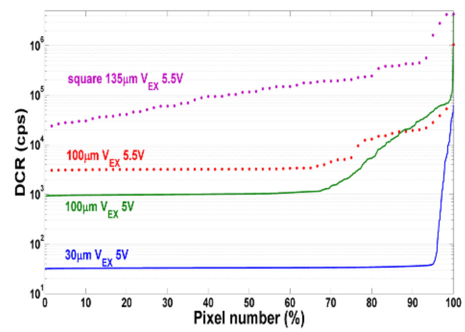
MiSPiA: at the end, a new start, EXPLOITATION!

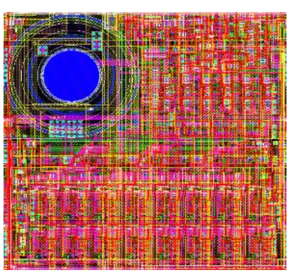
On December 31th 2013 the MiSPiA project came formally to the end, but it is certainly not over. In fact, MiSPiA outcomes and developed technologies already provided several important answers and products to the field of high-speed high-sensitive cameras. Nonetheless MiSPiA has still lot to contribute and impact on directing future exploitations and deployments along productive lines. The collaboration activities were one of the main success factors of the project and will develop further collaborative exploitation in brand new field, no doubt.

Main achievements in the project

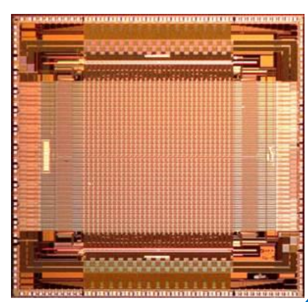
Overall MiSPiA proved many successful outcomes, important not only to successfully crown MiSPiA early objectives, but also to definitely exploit them in novel fields.

1- a set of new **state-of-the-art CMOS SPAD** (Single-Photon Avalanche Diode) detectors and arrays, with very low noise (DCR<80cps for 30µm SPADs), extremely high sensitivity (55% PDE at 400nm, >30% within 300-600nm, still 5% at 850nm); high Time-of-Flight (TOF) precision (40ps); very large aread (up to 500µm diameter). MiSPiA SPADs are best-in-class not only among CMOS SPADs, but also impressively compare with leading-edge custom SPAD.





2 – a set of 3D ranging **imagers for photon-timing** with best-detection performance so far reported, based on smart-pixels with 30µm SPADs and in-pixel time-to-digital converters (TDCs) for direct TOF measurement of individual single photons: both linear arrays and 32x32 imagers, acquiring 2D images and 3D movies at 100,000 frames/s fps with 5cm single-shot depth-precision and 0.9mm free-running precision at 200fps, 10bit photon-timing at 210ps resolution and 320ns full-scale range. Beyond 3D ranging and lidar, MiSPiA dTOF chips enable forth-coming first-photon challenging imaging, time-correlated single-photon timing (TCSPC) acquisitions of very fast (tens of ps) time-resolved optical waveforms, fluorescences, and spectra in a broad range of biological essays, microscopy, optical tomography, spectrometry.



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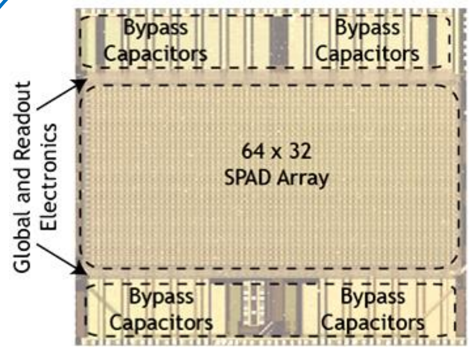
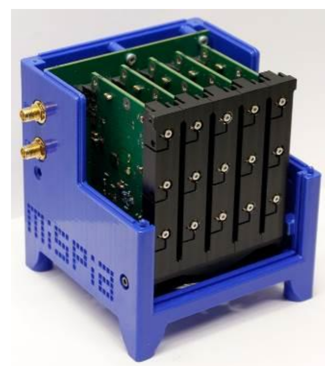


3 – a set of 3D ranging **imagers for and photon-counting** with among the best cutting-edge performance among SPAD imagers for 3D "indirect TOF", based on smart-pixels with 30µm SPADs and digital counters for phase-resolved detection of either pulsed-light (PL) or continuous-wave (CW) actively illuminate scenes: linear arrays or 64x32 imagers acquiring 2D images at 100,000fps and 3D maps movies at 33,000fps, with 9bit photon-counting dynamics. Beyond 3D ranging, these MiSPiA iTOF chips are being used in time-gated acquisitions of fast (sub-ns range) optical waveforms of fluorescence and diffusive specimen in different applications of fluorescence life-time imaging (FLIM and FRET), optical tomography (DOT), fluorescence correlation spectroscopy (FCS), and micro (bio)array proteomics.

4 –compact and modular low-power fully-programmable active illuminator, to be coupled with 3D iTOF cameras for short-ranges up to 50m, based on LEDs and solid-state lasers, able to switch between two operating mode, namely pulsed-light (PL) mode, with flashes lasting few hundreds of ns, or continuous-wave (CW) modulation, at MHz rates. The developed illuminator can operate to different depth ranges, from few meters (e.g. for gaming of smart-TV applications) to some tens of meters (e.g. for automotive or robotic applications).



5 –reconfigurable user-friendly compact camera module for 2D/3D acquisitions of pictures and movies by any (linear array or imager, iTOF or dTOF based) MiSPiA CMOS SPAD imagers, to be remotely controlled by a remote pc through USB 2.0 link and a graphical user interface. All smart processing can be performed on-board thanks to a powerful FPGA and SRAM, able to store high-throughput streams of data. The software interface allows to easy control all acquisition parameters and either 2D imaging or 3D ranging modes, photon-counting or photon-timing acquisitions, acquisition frame-rate, and picture or video display, thus easing further off-line data-processing.

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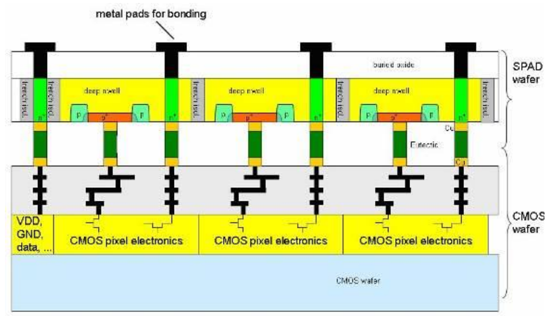
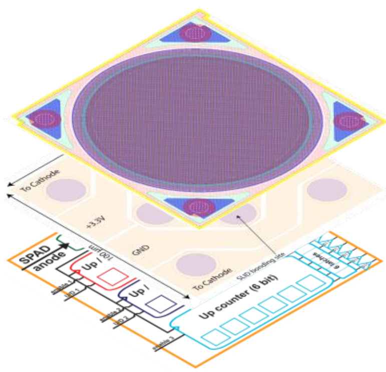
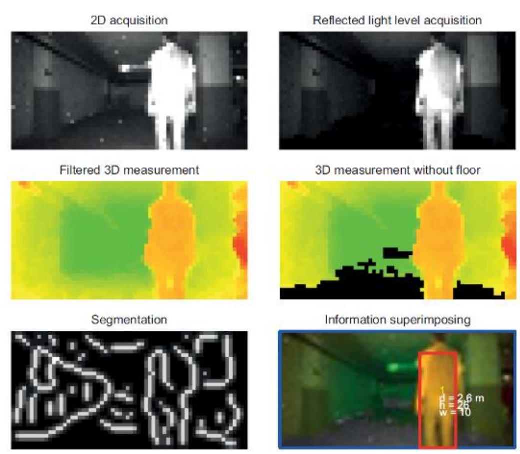
6 - two different cost-effective CMOS technologies for SPAD manufacturing, in a robust and reliable 0.35µm node, to fabricate either fully-planar single-chip front-illuminated CMOS FrontSPAD imagers or advanced wafer-to-wafer bonded back-illuminated SOI-based BackSPAD imagers. The FrontSPAD technology is low-cost and provides high-

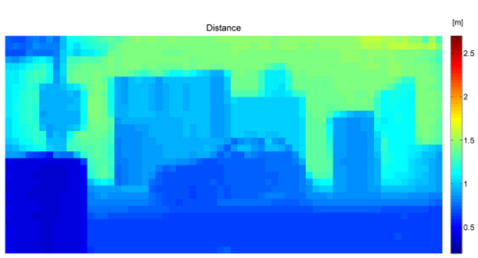


performance all-silicon CMOS SPAD imagers in compact one-chip solution. The BackSPAD technology instead allow to exploit the best detection performance out of the SOI SPAD together with the best counting and timing performance out of the CMOS electronics. Further exploitation of the BackSPAD technology is to bridge the gap among Silicon SPADs and III-V semiconductor-based devices, to provide single-photon sensitivity to advanced imaging in the near-infrared, up to 1.7µm wavelength.



7 – tests and characterization in short-range safety automotive scenarios, under different experimental conditions, indoor and outdoor, in static and dynamic scenarios, in every-day standard traffic conditions, in either daylight, twilight or night-time. The expertise acquired during tests allowed to develop better in-sights on 3D vision in automotive field and enabled the definition of pros and cons of optical vision systems compare to other technologies, and of single-photon counting-based optical techniques versus standard analogue ones based on linear-mode single-pixel photodetectors or CMOS video cameras.





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