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Multi-pixel Geiger mode imager for medical application.

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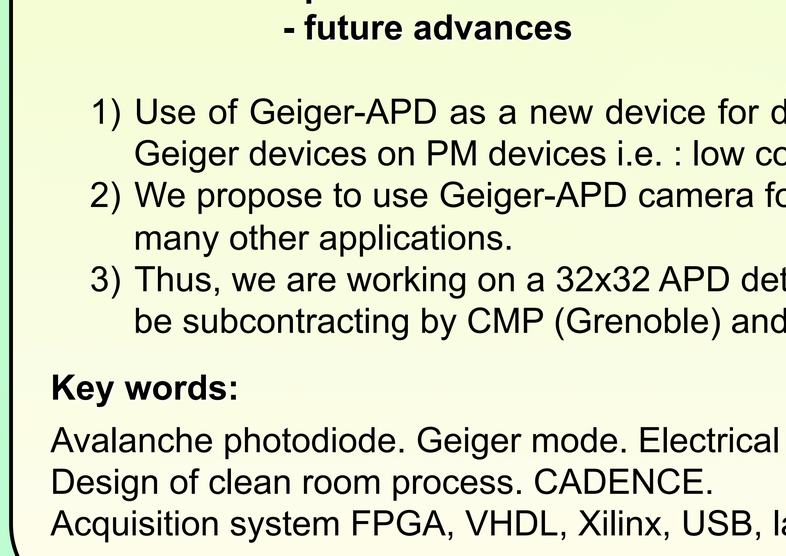
Objective : Geiger APD design, process manufacturing and characterization.

- performances
- future advances

1) Use of Geiger-APD as a new device for detection of low light flux instead of PM detectors thanks to the various advantages that benefited the Geiger devices on PM devices i.e. : low cost, high integration and imaging, high QE…
2) We propose to use Geiger-APD camera for applications based on detection of low light flux, such as cell biology, dermatology, astrophysics and many other applications.
3) Thus, we are working on a 32x32 APD detector (1024 pixels) including detectors and processor based on CMOS standard technology which will be subcontracting by CMP (Grenoble) and manufacturing by AMS (Austria Microsystem).

Key words:
Avalanche photodiode. Geiger mode. Electrical simulations, VHDL language.
Design of clean room process. CADENCE.
Acquisition system FPGA, VHDL, Xilinx, USB, labview.

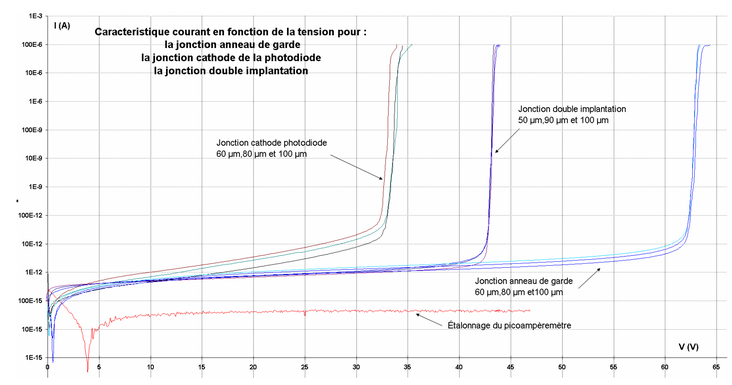
Technological constraints of Geiger mode and the structure selected (CMOS 0,35 opto).



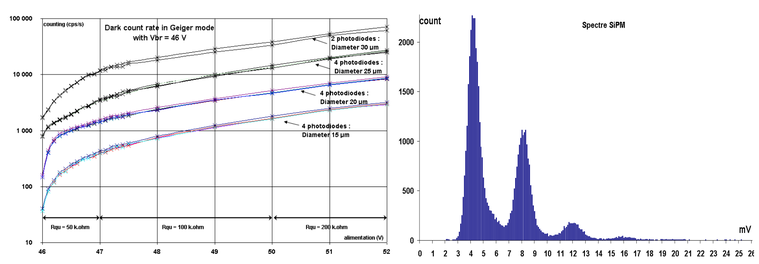
The CMOS Opto process option provides enhanced optical sensitivity for embedded photodiodes and high density CMOS camera products.
• High sensitivity low dark current 0,35 micron CMOS Opto process
• Low cost – only 1 additional process step (Inorganic ARC Layer)
• Customer-specific wavelength optimized ARC layer based on electrical and optical simulations possible
• 14micron EPI substrate (20micron EPI substrate optional)
• All features of advanced mixed signal 0.35 micron CMOS available:
- 3 to 4 metal layers
- Poly Insulator Poly and Metal Insulator Metal Caps
- 3.3V/5V Digital Logic

Characteristics of Geiger-APD technology

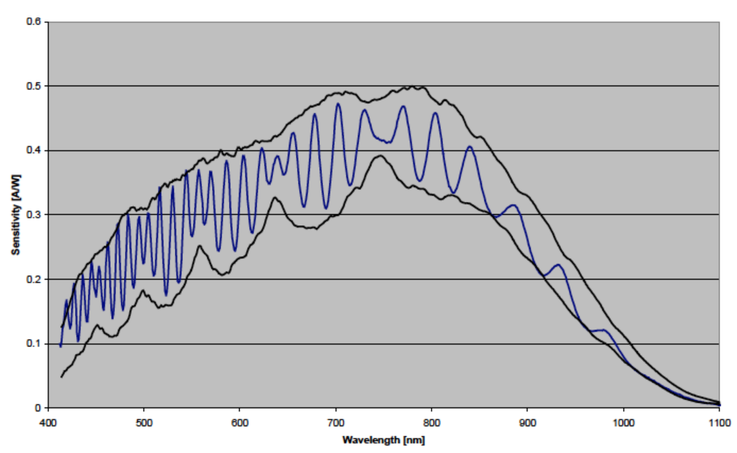
1) Breakdown voltage V_{br}:



2) Thermal noise for a photodiode and SiPM:

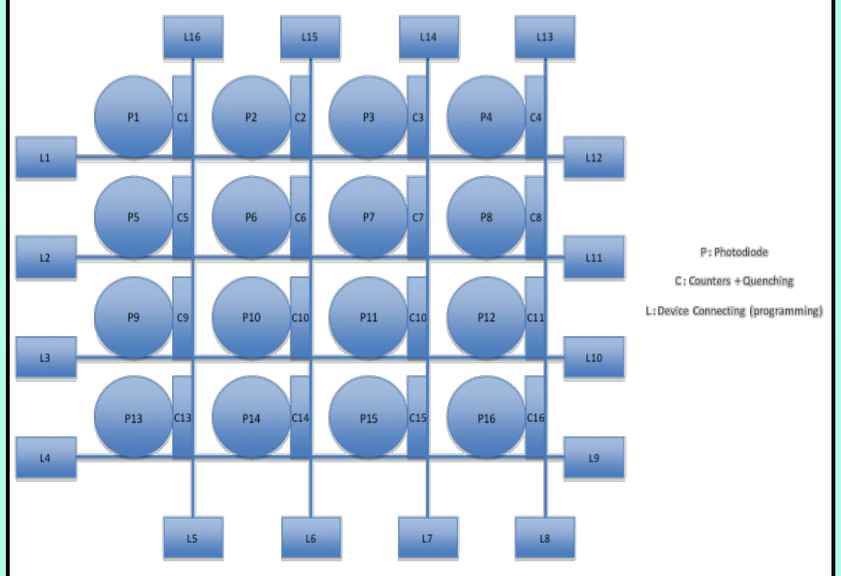


3) Responsitivity Curve of Photodiode:

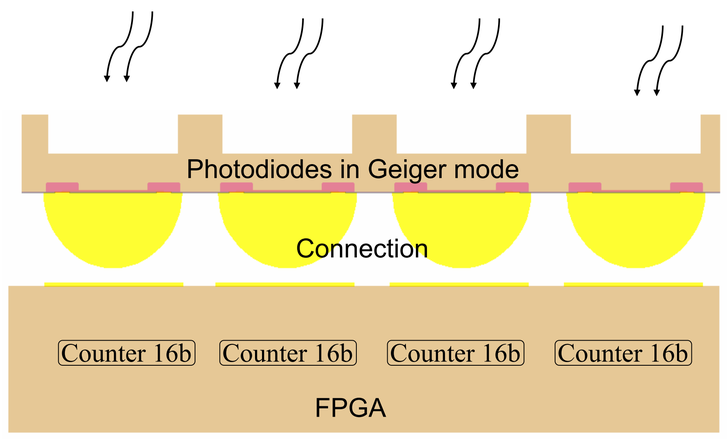


Future Geiger Imaging

1) Imaging 32x32 photodiodes using CMOS 0,35 opto standard technology.



2) Imaging using 3D technology.



Conclusion :

The design of photodiodes technology is in progress today. We are preparing layouts for submission of a process very soon and characterizing step is planned after reception of samples.
Characteristics of our photodiodes are foreseen to be:
• Breakdown voltage : **18,0V (± 0,1V)**
• Thermal noise: **<100 Hz (of thermal events)**
for 10 µm diameter for 0,5V over bias
<10 Hz
for 5 µm diameter for 0,5V over bias

Work program :
Expected Quantum Efficiency : **70% with λ ∈ [500 ; 800] nm.**
Expected Sensitivity : **single photon**.

Perspectives :
1) Kilo pixel imaging
2) Mega pixel imaging.

A way of possible research is volume integration of the detector and the FPGA, with access to all pixels.