

STMicroelectronics
Industrial and Multisegment Sector R&D - Catania

- PicoSEC -
STMicroelectronics activities
Overview

D. Sanfilippo

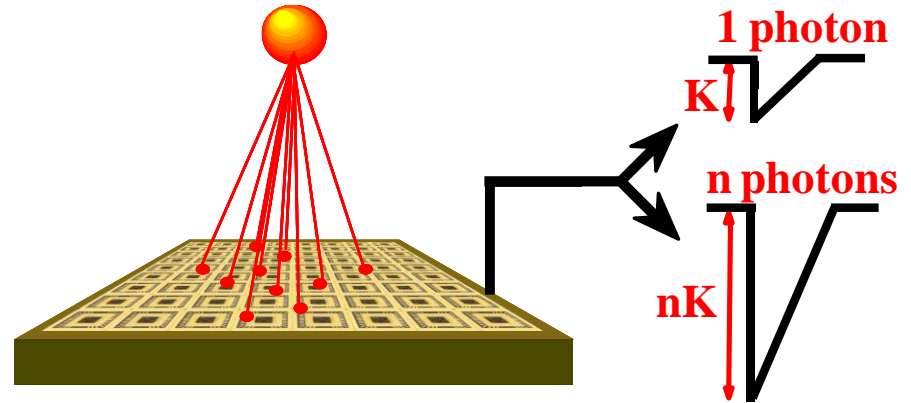
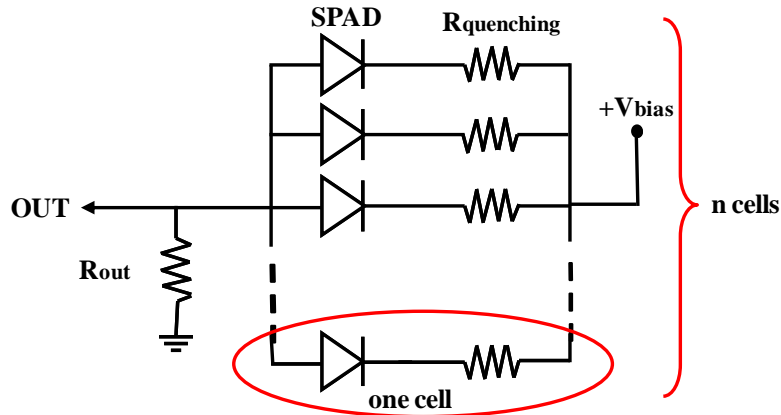
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Outline

- ▣ **The Silicon PhotoMultiplier**
- ▣ **Technology overview**
- ▣ **Electro-optical characteristics**
- ▣ **STMicroelectronics activities overview**

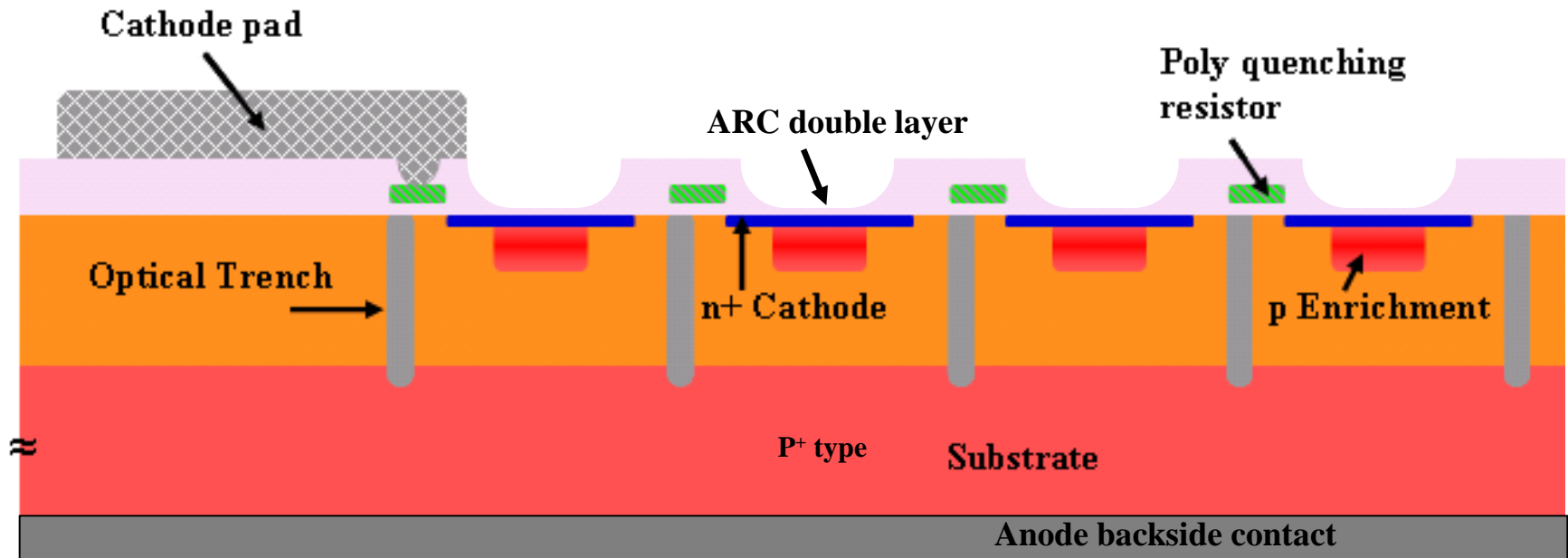
The Silicon Photo Multiplier (SiPM)



- The Silicon PhotoMultiplier (SiPM) is a multi-cell semiconductor photon sensor; each cell operates as an independent photon counter
- Cells are biased above the breakdown voltage and operate in Geiger mode; the discharge is quenched by a resistor connected to each diode
- The individual signal amplitude does not depend on the number of photons firing the cell: each element operates digitally as a binary device
- The SiPM output signal amplitude is the sum of signals from all the fired cells: it works as an analog detector that can measure light intensity

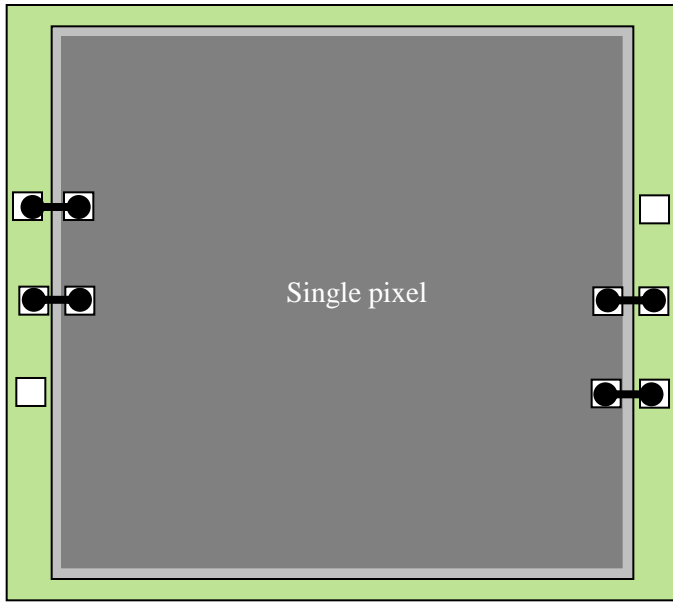
Technological features

- N on P technology
- Shallow junction
- In-situ doped poly-silicon cathode layer
- Integrated poly-silicon resistors
- Thin optical trench with metal filling
- Tunable Anti-reflection coating
- Dedicated gettering techniques
- Double layer passivation

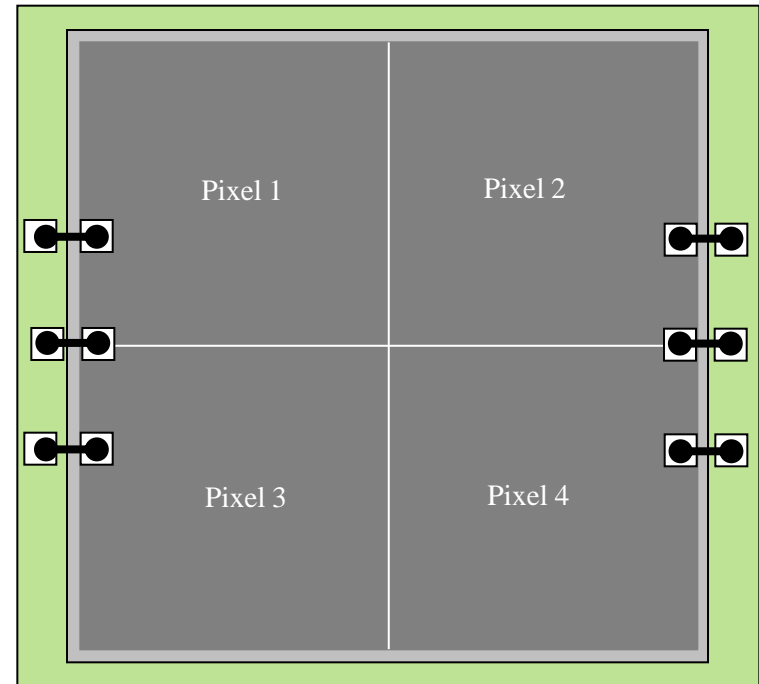


Device layout

Single pixel

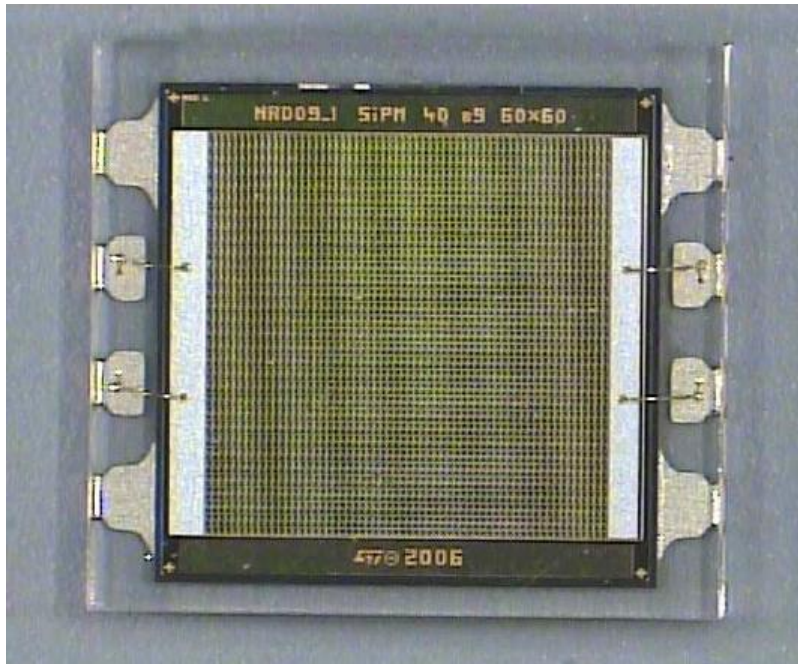


Monolithic Array 2x2

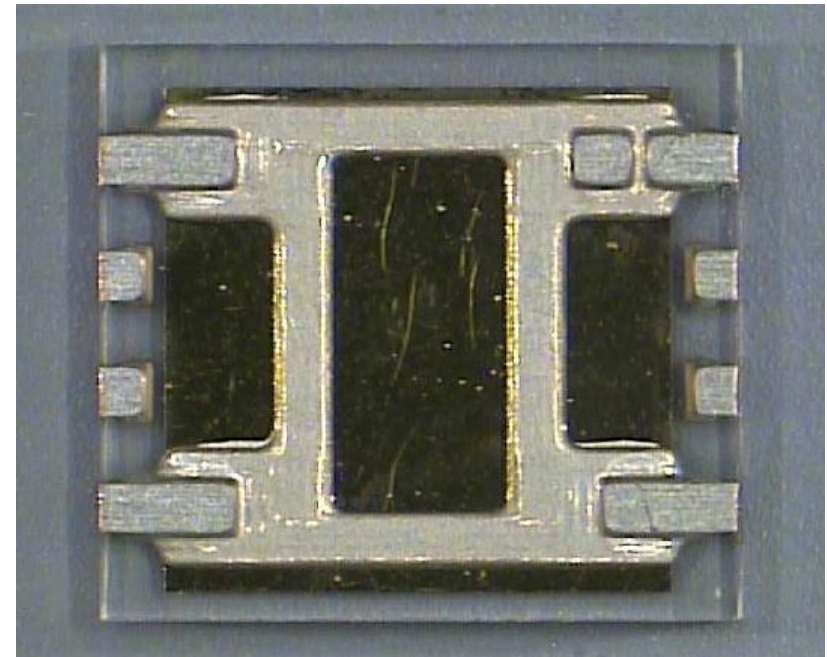


SMD Optical Package

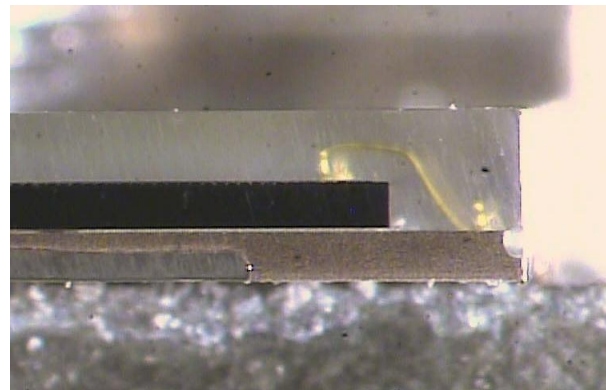
Top view



Bottom view



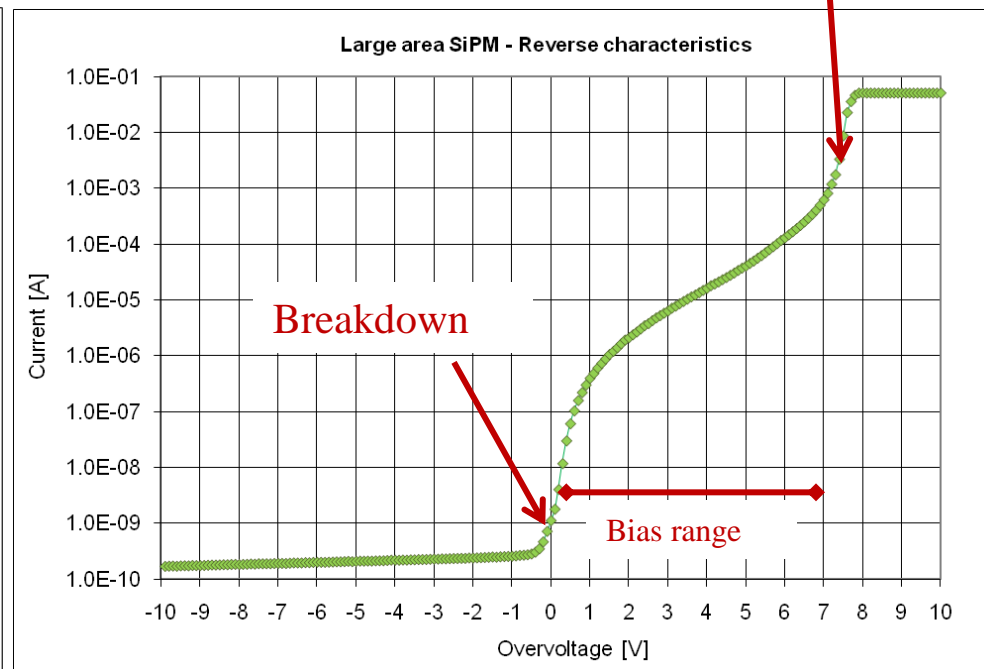
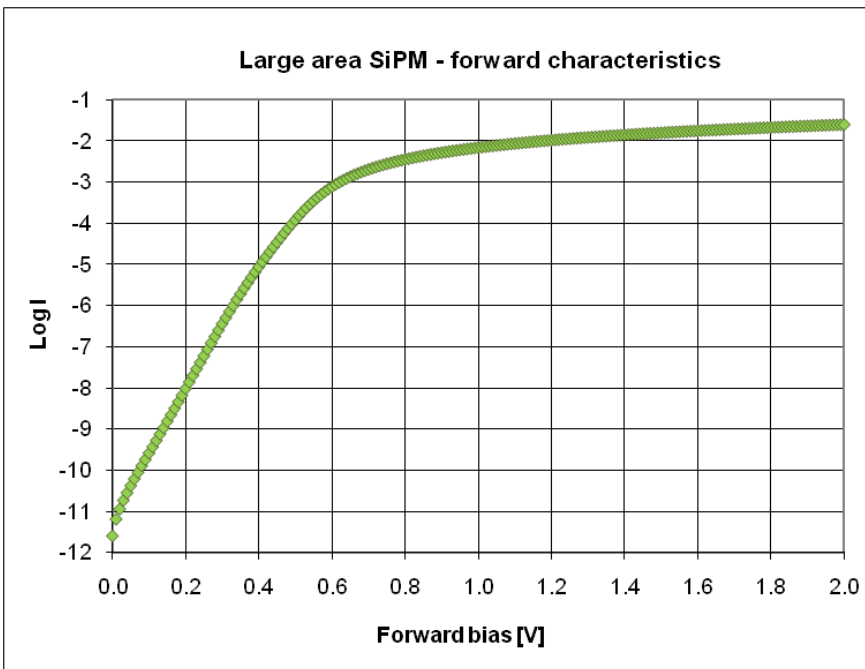
Cross section



SiPM electrical characteristics

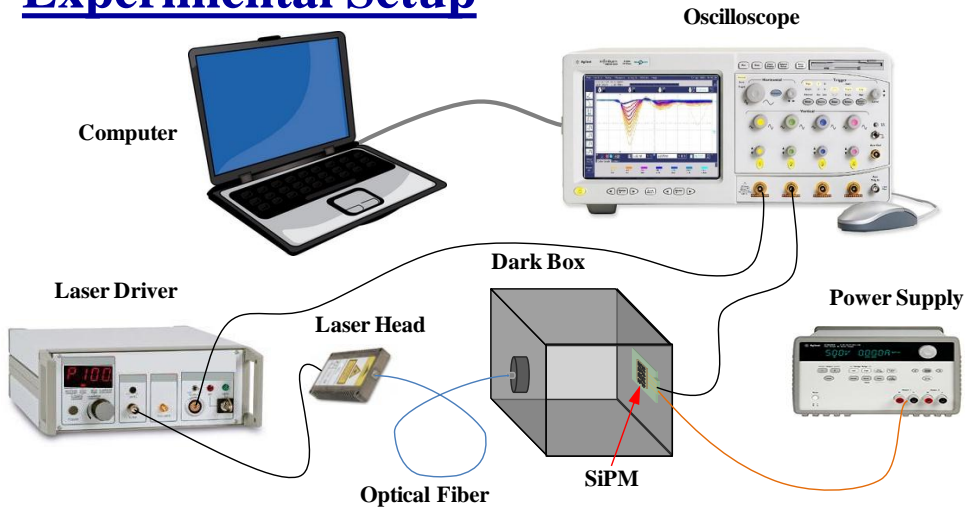
- Typical Breakdown voltage: 28 V
- Operative over-voltage range (OV): 3 ÷ 6 V
- Gain: $\sim 3 \cdot 10^6 \cdot @ 3 \text{ V OV}$
- Dark current: $\sim 250 \text{ nA/mm}^2 @ 3 \text{ V OV}$

High bias discharge

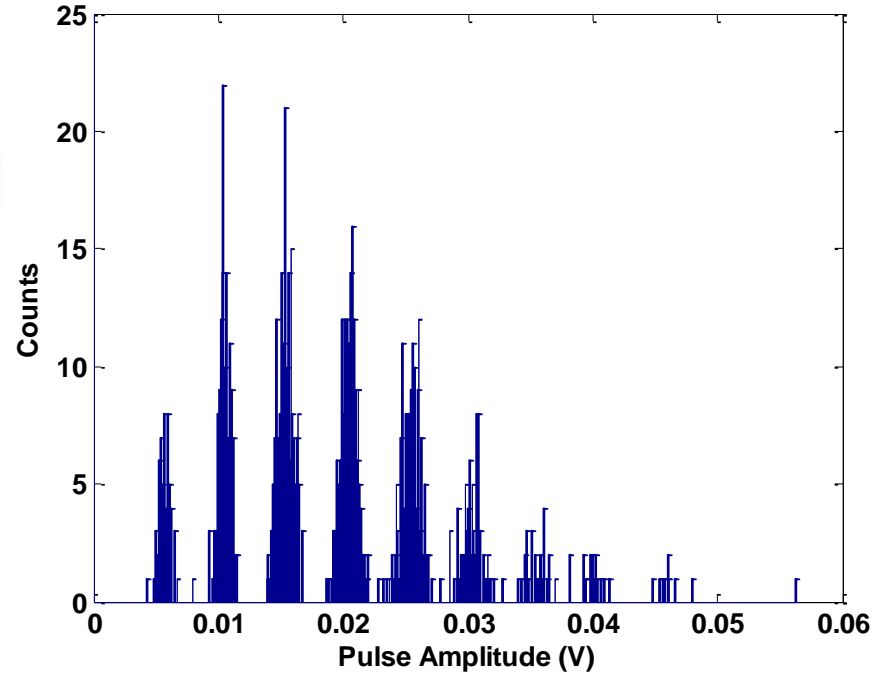


Optical characterization

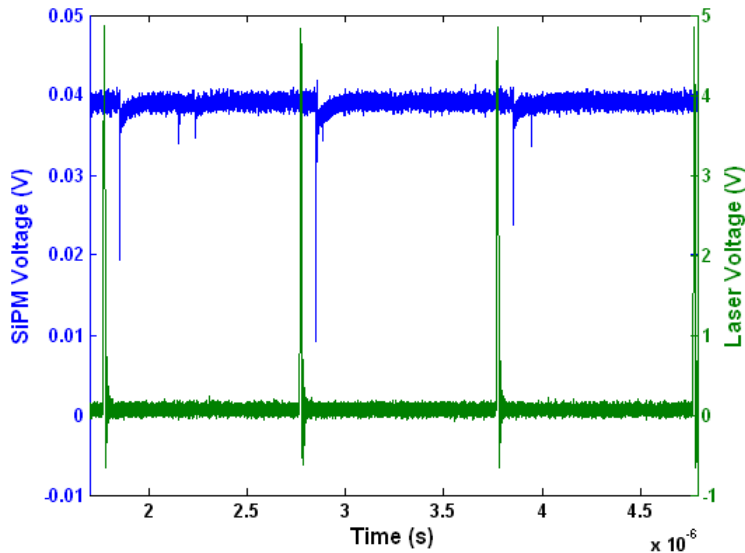
Experimental Setup



Pulse Amplitude Spectrum



Oscilloscope acquisition



Activities overview

STMicroelectronics core activity:

Develop a dedicated photon sensor for the Project, in particular a Silicon PhotoMultiplier (SiPM).

Specific items:

- Design a new device with a dedicated layout**
- Optimize the fabrication process**
- Design and develop a functional package**
- Perform the electrical characterization**
- Perform the optical characterization**

Thank You!

