

# **Silicon photosensors and microelectronic systems**

*Prof. Gian-Franco Dalla Betta*

*Dipartimento di Ingegneria industriale, Università di Trento*

## Course objectives and contents

Silicon photosensors and radiation detectors are widely employed in several fields of fundamental and applied research, as well as for medical imaging and industrial diagnostics.

The aim of this course is to provide students with basic knowledge about silicon radiation detectors, related fabrication technologies and application fields.

## Prerequisites

Basic knowledge of semiconductor device physics and electronics

## Program

- Introduction. Application fields.
- Interaction between radiation and semiconductors.
- Operation principle of silicon detectors, Signal formation, Ramo's theorem.
- Signal processing: spectroscopic chain, noise considerations,
- Figures of merit: responsivity, quantum efficiency, detection efficiency, response speed, spatial resolution, energy resolution, radiation hardness.
- Categories and variants of silicon detectors: Photodetectors: photoresistors, phototransistors, color sensors. Detectors for spectroscopy: PIN diodes, drift detectors. Position sensitive detectors: strip detectors, pixel detectors, CCDs.
- Fabrication technologies.
- Simulation and design methodologies for silicon detectors
- Radiation damage: Bulk and surface radiation damage in silicon detectors. Radiation hardening by design and technological solutions.
- Detectors with three-dimensional electrodes (3D detectors). Operation principle, simulations, technology, selected results, radiation hardness. Active edge detectors. Applications other than high energy physics: neutron detection, FELs, dosimetry.
- Avalanche based detectors: impact ionization effects, different detector types (APD, LGAD, SPAD).
- The Silicon PhotoMultiplier (SiPM).
- Monolithic Active Pixel Sensors: The CMOS MAPS approach: general features, pros and cons, examples of implementations. Monolithic integration of transistors and detectors on high resistivity silicon: pioneering works, the DEPFET, other relevant results.