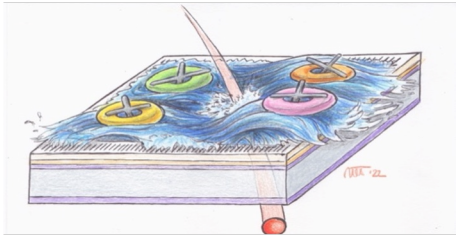


RD50-2023-09
RadHard AC-LGAD

State-of-the-art Radiation Resistant AC-coupled Resistive LGAD

Roberta Arcidiacono (UPO & INFN TORINO) on behalf of the RD50-2023-09 Common Project
speaker: Brendan Regnery (KIT)

1st DRD3 week on Solid State Detectors R&D – WG2 – June 2024

RadHard AC-LGAD: members

Project Leader: **Roberta Arcidiacono** (INFN Torino & UPO)
Indicated project cost: 75 keuros
Granted RD50 contribution: 34 keuros

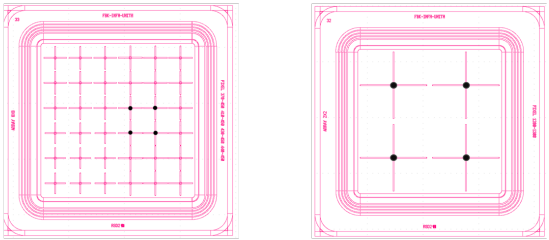
Participating Institutes: 11
(all RD50 members)

INFN Torino	Roberta Arcidiacono
FBK	G. Paternoster
Karlsruhe Institute of Technology	Alexander Dierlamm
University of Montenegro	Gordana Medin
HEPHY	Thomas Bergauer
INFN Perugia	Francesco Moscatelli
Santa Cruz Institute for Particle Physics	Simone Mazza
University of Science and Technology of China	Yanwen Liu
Brown University	Jennifer Roloff
Fermilab	Artur Apresyan
Vilnius University	Thomas Ceponis

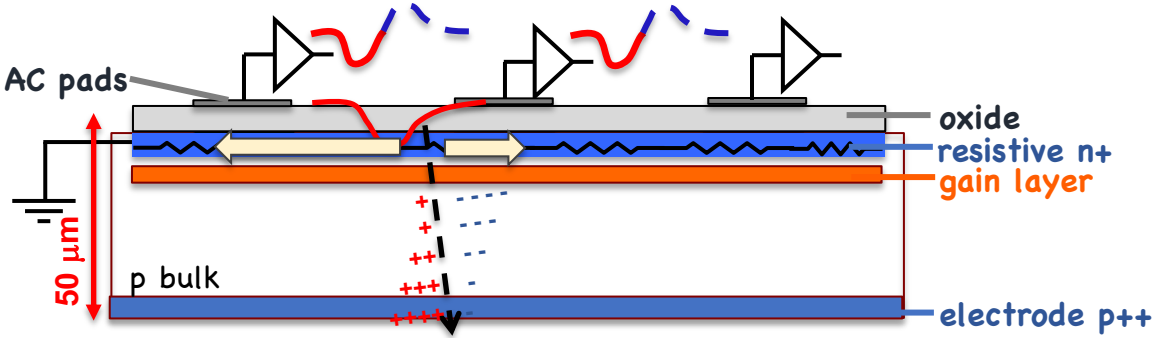
RadHard AC-LGAD: introduction

The AC-coupled Resistive LGAD [AC-LGAD or RSD] is an innovative silicon sensor device which has demonstrated so far excellent time and space resolutions.

The prototypes produced by FBK are proof-of-concept devices optimized in terms of sensor design parameter, to obtain the most uniform and performant charge sharing, while the gain layer (shallow, not carbonated design) has not been optimized in terms of radiation hardness.



RSD2 – cross-shaped electrodes
450- and 1300- um pitch



Charge is induced on the resistive layer (spread is controlled by the n+ resistivity, metal pad capacitance, pitch, system inductance). Signals are generated on the near-by AC pads.

RadHard AC-LGAD: goals

The goal of the project is to ***develop improved radiation hard AC-LGADs***

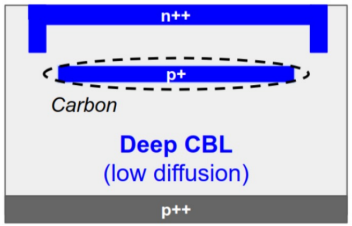
Proposal: ***implement the state-of-the-art radiation hardening techniques to the most performing FBK designs, in order to achieve radiation hard sensors*** **up to 2-3e15 1MeV-n_{eq}/cm^2.**

Objectives:

- **One** RadHard AC-LGAD **prototype run** (**10 wafers** batch@ FBK)

  Split table will include:

  1. *shallow carbonated boron implant with the CBL activation scheme*
  2. *deep carbonated boron implant with the CBL activation scheme*



- **Irradiation with neutrons and protons** *(up to 3E15 1MeV-n_{eq}/cm^2)*
- Study **effect on** all sensor components (**gain, oxide and n+ resistive layer**), on **signal sharing** and **time/space resolutions**.

RadHard AC-LGAD: timeline

Project Timeline

- **3D TCAD simulation to study/optimize the surface signal spread in large pixels**
- Definition of the reticle layout and split table for the prototype run (M6)
- Wafer layout and mask production (M8)
- Batch production with boron + carbon gain implant at FBK (M15)
- Develop a 3D TCAD model to simulate the sensor cell behaviour at various irradiation levels (M12)
- Tests on wafer at FBK, dicing of 5 wafers, distribution to participating institutes (M15)
- Sensor testing before irradiation (M16)
- Sensor irradiations (protons and neutron irradiations) (M18)
- Dicing of remaining wafers (M20)
- Sensor testing after irradiation (M24)

RadHard AC-LGAD: status

Project still in the **starting phase**

- Paperwork to collect Funds and sent the Purchase Order to FBK ✓
- TCAD simulation ongoing (very early stage) @Perugia to study/optimize the **surface signal spread** in *large pixels* ("cross-shaped" electrodes), in *small pixels* (fully metallized surface), and *strips* → **optimizing electrode design and sensor design** (oxide layer thickness, resistivity…)

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Next (summer time)

- Define common test structures and baseline designs
- Collect wish-list for the application-oriented small-scales prototypes to be implemented in the RadHard AC-LGAD reticle.

FBK currently fully booked with multiple LGAD-based sensor productions

- Expect design of the reticle/wafer layout towards end of summer

Thank you!