Contribution ID: **180** Type: **Oral**

Development of AC-LGADs for large-scale high-precision time and position measurements

Wednesday, 17 February 2021 17:10 (20 minutes)

Low Gain Avalanche Detectors (LGADs) are thin silicon detectors (ranging from 20 to 50 um in thickness) with moderate internal signal amplification (up to a gain of˜50) [1]. LGADs are capable of providing measurements of minimum-ionizing particles with time resolution as good as 17 pico-seconds [2], [3]. In addition, the fast rise time (as low as 150 ps) and short full charge collection time (as low as 1 ns) of LGADs are suitable for high repetition rate measurements in photon science and other fields.
The first implementation of this technology will be with the High-Granularity Timing Detector (HGTD) in ATLAS and the Endcap Timing Layer (ETL) in CMS for the high luminosity upgrade at the Large Hadron Collider (HL-LHC). The addition of precise timing information from LGADs will help mitigate the increase of pile-up and improve the detector performance and physics sensitivity.
The current major limiting factor in granularity is due to structures preventing breakdown caused by high electric fields in near-by segmented implants. As a result, the granularity of LGAD sensors is currently limited to the mm scale.
In this paper, we present measurements on AC-LGADs (also named Resistive Silicon Detectors RSD), a version of LGAD which has shown to provide spatial resolution on the few 10‘s of micrometer scale [4]. This is achieved by un-segmented (p-type) gain layer and (n-type) N-layer, and a di-electric layer separating the metal readout pads. The high spatial precision is achieved by using the information from multiple pads, exploiting the intrinsic charge sharing capabilities of the AC-LGAD provided by the common N-layer. It depends on the location, and the pitch and size of the pads.
Using a focused IR-Laser scans directed alternatively at the read-out side on the front and the bias side on the back of the AC-LGAD, the following detector parameters have been investigated in RSD produced by FBK [4]: sheet resistance and termination resistance of the n-layer, thickness of the isolation di-electric, doping profile of the gain layer, and pitch and size of the readout pads.
The data are used to recommend a base-line sensor for near-future large-scale application like the Electron-Ion Collider where simultaneous precision timing and position resolution is required in the tracking detectors.

[1] H.F.-W. Sadrozinski, A. Seiden and N. Cartiglia, “4D tracking with ultra-fast silicon detectors”, 2018 Rep. Prog. Phys. 81 026101
[2] M. Ferrero et al., “Radiation resistance LGAD design”, NIMA 919 (2019) 16–26.
[3] A. Seiden et al, “Potential for Improved Time Resolution Using Very Thin Ultra-Fast Silicon Detectors (UFSDs) “, https://arxiv.org/abs/2006.04241
[4] M. Tornago et al, “Resistive AC-Coupled Silicon Detectors: principles of operation and first results from a combined analysis of beam test and laser data”, https://arxiv.org/abs/2007.09528

Primary authors: SADROZINSKI, Hartmut (University of California,Santa Cruz (US)); MAZZA, Simone Michele (University of California,Santa Cruz (US)); SEIDEN, Abraham (University of California,Santa Cruz (US)); SCHUMM, Bruce Andrew (University of California,Santa Cruz (US)); RYAN, Eric (University of California, Santa Cruz); ZHAO, Yuzhan (University of California Santa Cruz); REN, Heyi (University of California, Santa Cruz); PADILLA, Rene (UC Santa Cruz); HYSLOP, Sean (University of California, Santa Cruz (US)); GEE, Carolyn (University of California,Santa Cruz (US)); TARKA, Michal (UCSC); GALLOWAY, Zachary; CARTIGLIA, Nicolo (Universita e INFN Torino (IT)); MANDURRINO, Marco (INFN); SOLA, Valentina (Universita e INFN Torino (IT)); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); FERRERO, Marco (Universita e INFN Torino (IT)); TORNAGO, marta; SIVIERO, Federico (INFN - National Institute for Nuclear Physics); Dr PATERNOSTER, Giovanni (FBK); FICORELLA, Francesco (FBK); BOSCARDIN, Maurizio (FBK Trento)

Presenter: SADROZINSKI, Hartmut (University of California,Santa Cruz (US))

Session Classification: Session 8: LGAD 1

Track Classification: LGAD