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# LGAD Development for the LHC's High-Luminosity Upgrade

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The need for 4D (fast timing in addition to 3D resolution in space) silicon particle detectors has become very apparent with the introduction of the High-Luminosity (HL) upgrade at the LHC. Timings on the order of tens of picoseconds will allow better reconstruction of the ˜200 primary vertices along the beam line in every bunch crossing. Correct association of tracks with primary vertices is particularly difficult closer to the beam axis where the track density is greatest and reconstruction with 3D detectors alone is insufficient.
The University of Birmingham, University of Oxford, the Rutherford Appleton Laboratory, and the Open University are developing and testing new LGAD sensors. This project, aimed at developing Ultra-Fast Silicon Detectors (UFSD) of characteristics and performances suitable for use at HL-LHC High Granularity Timing Detector (HGTD), is being developed in collaboration with Teledyne e2v.
The first fabricated batch of 22 six-inch wafers, featuring 50 μm thick high resistivity epi layer with different gain layer implants was completed successfully.
We will present the LGAD design process and compare the results with Synopsys TCAD simulations. We will discuss I-V and C-V measurements across wafers for device sizes ranging between 1 mm, 2 mm, 4 mm and 2x2 arrays of 1 mm devices, and comparisons to PiN diodes where the gain layer is not present. Gain measurement using TCT laser injection on both PiN and LGAD individually packaged devices will be shown. Preliminary timing measurements and test results before and after proton irradiation will also be provided.

## Your name

## email

laura.gonella@cern.ch

## Title

## Nationality

## Institute

**Authors:** BORTOLETTO, Daniela (University of Oxford (GB)); ALLPORT, Philip Patrick (University of Birmingham (UK)); JORDAN, Douglas (Teledyne e2v); VILLANI, Enrico Giulio (STFC - Science & Technology Facilities Council (GB)); KOPSALIS, Ioannis (University of Birmingham (GB)); MULVEY, Jonathan (University of Birmingham); STEFANOV, Konstantin (University of Oxford (GB)); GONELLA, Laura (University of Birmingham (UK)); GAZI, Martin; PLACKETT, Richard (University of Oxford (GB)); MCMAHON, Stephen (Science and Technology Facilities Council STFC (GB))

**Presenter:** MULVEY, Jonathan (University of Birmingham)

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