



Contribution ID: 35

Type: **Parallel session talk**

Optimization of Ultrafast Silicon Detectors for Timing Applications in Future High Luminosity Collider Experiments

Wednesday 8 October 2025 16:50 (20 minutes)

There is a high priority in particle physics for research and development into instrumentation motivated by the physics goals of the next generation of experiments. Several challenges need to be addressed, including high pile-up, as future hadron and muon colliders will feature both high in- and out-of-time backgrounds. A time resolution of the order or below ten picoseconds allows for the mitigation of these backgrounds while also providing time-of-flight measurements that can be used to distinguish between different hadron species in a broad momentum range. Ultrafast silicon detectors, in combination with other detector technologies, must be tailored to be able to provide the measurements needed for specific applications, and we have started exploration focusing on the optimization of their design parameters. We present our ongoing efforts to study signal formation and timing resolution in low gain avalanche diodes (LGADs) of different areas, thicknesses, and gains, with the goal of optimizing cell sizes and fabrication parameters for large scale timing applications.

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Session Classification: SHARED SESSION

Track Classification: RDC 3 Solid State Tracking