Contribution ID: **42** Type: **not specified**

The mortality study on irradiated W36 LGADs and PINs for tuning the HV safety parameters and establishing the turning point for the irreversible breakdown (Part I): Using TCT-SPA with 800 nm of fs-laser at ELI

Wednesday 23 June 2021 13:30 (20 minutes)

The HL-LHC presents unprecedented challenges and timing information is expected to play a key role in mitigating the impact of pile-up in both ATLAS (HGTD) and CMS (MTD-ETL). However, yield and stability after heavy irradiation remain a concern. The presented results are the results of the main part of the second big experimental campaign on LGAD fatalities and its irreversible breakdown after being irradiated to the fluences of the LHC-HL interest; the study lasted almost one month at ELI Beamlines since very dedicated and systematic approach was applied. Only part based on TCT-SPA with 800 nm of fs-laser beam is shown here. Results from TCT-TPA with 1550 nm of fs-laser beam are shown in a separate talk. The first mortality campaign at ELI was performed and completed successfully in February and the results have been shown at the TREDI2021 Workshop. This is the second campaign dedicated to tuning the HV safety parameters. This time, starting with a low pulse energy of 1 pJ the bias was increased from 100 V to 650 V (later this limit was extended to 670 V) whereas the signal was observed on the oscilloscope (waveforms were recorded) and the leak current was monitored. This procedure was repeated for increasing pulse energies with a 5 pJ step until 50 pJ. For every scan we searched for the first symptoms of instability in the signal. When the signal started slightly "jumping"the values of laser energy and HV bias was noted as the "stability threshold". After reaching the threshold the bias was further increased (to 670 V) in order to explore the "unstable region"; this was possible as long as the signal was safely measured by the scope. When the signal was high and significantly deformed the scope was disconnected and only the leakage current was observed with increasing bias. In the end the energy was set at 50 pJ and the bias was increased until the breakdown of the sensor was achieved. The damaged sensors were finally inspected by optical and electronic microscopes. The fatality signatures and the HV threshold values for LGAD's irreversible breakdown will be shown and discussed.

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Session Classification: LGAD Mortality Studies