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The Front-end Electronics for the 1.8-kchannel SiPM Tracking Plane in the NEW Detector

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NEW is the second phase of NEXT, an experiment aiming at searching neutrinoless double-beta decay. Neutrinoless events can only be told from very close energy background events by using to a topological signature produced at the SiPM tracking plane, making this one of the strongest features in NEXT: a high background rejection. The present work describes in detail the front-end electronics in the NEW detector as well as the new cabling solutions that have been developed. The tracking plane consists of close to 1800 sensors with a 1-cm pitch arranged in twenty-eight 64-SiPM boards.

Summary

NEW is the second phase of NEXT, an experiment aiming at searching neutrinoless double-beta decay [1]. Neutrinoless events can only be told from very close energy background events by using to a topological signature produced at the SiPM tracking plane, making this one of the strongest features in NEXT: a high background rejection.

The present work describes in detail the front-end electronics for the SiPM tracking plane in the NEW detector as well as the new cabling solutions that have been developed. The tracking plane in NEW consists of close to 1800 sensors with a 1-cm pitch arranged in twenty-eight 64-SiPM boards.
In order to keep background events to a minimum, front-end electronics are placed nearby the detector but beyond the lead castle that surrounds the TPC, with a total cable length of 5 m from the sensor to the electronics. This poses a challenge in the design of a cabling solution that (1) is radio-clean enough inside the detector, (2) keeps enough signal-to-noise ratio in the relevant signal bandwidth for the gated integrator with a 5 m cable, (3) is cost-effective, (4) includes SiPM biasing voltage wires and (5) is also valid for the final NEXT phase (NEXT-100). A combination of (a) two-layer kapton cables (to avoid adhesives that would increase radioactive background) with broad-side coupled traces inside the detector and (b) differential transmission lines on fine-pitch FFC cables outside the detector is discussed, together with measurements of signal-to-noise ratio.
The cable length together with a high channel count imply profound changes in the front-end design for NEW. As a result, a new low-power differential transimpedance amplifier has been designed, a per-channel automatic offset voltage compensation has been developed, per-channel power has been reduced in a factor of 3.5, the number of channels per front-end board has been increased in a factor of 4, a higher signal-to-noise ratio has been achieved, FPGA-based zero-suppression is carried out at the front-end level and the DAQ interface throughput has been increased and is compatible with CERN RD-51 SRS's DTCC link specification [5].
The authors believe these developments can be of interest to other researchers using SiPMs in their experiments, especially in tracking applications, motivating them to submit the present abstract summary.

References

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