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A cryogenic RICH detector demonstrator for SiPM operation with integrated flex-PCB electronics

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Silicon photomultiplier (SiPM) arrays are strong photodetector candidates for future RICH detectors owing to their excellent single-photon detection efficiency, time resolution and fine granularity. The main challenge in operating SiPM arrays is the dark-count rate (DCR), especially after irradiation damage. Operation at cryogenic temperature effectively mitigates the DCR. The design and integration of a cryostat in a RICH detector pose a technical challenge. A modular cryostat demonstrator is being developed at CERN to characterise SiPM arrays at liquid-nitrogen temperatures ($\sim$ 80 K) under different experimental conditions. The design of the demonstrator addresses critical technical aspects such as the coupling of SiPM arrays to a cold block, the operation of multi-channel readout electronics in vacuum and the transmission of the SiPM array analogue signals over distances of several centimetres. This demonstrator will provide valuable insights for the scalability of the system to large photodetector areas. A flex-PCB solution has been adopted for the transmission of analogue signals from the cryogenic-cooled SiPM arrays to the readout electronics at room temperature. A prototype of the flex-PCB has been designed and produced to evaluate the effect of 15cm-long high-density traces on signal integrity and time resolution. The results demonstrate that signal integrity is well preserved. A single-photon time resolution of 107ps (σ) was measured using a picosecond-pulsed laser setup. These results represent an important step in the development of the cryostat demonstrator.

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