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The Mu2e Calorimeter Photosensors

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The Mu2e experiment at FNAL aims to measure the charged-lepton flavor violating neutrinoless conversion of a negative muon into an electron. The conversion results in a monochromatic electron with an energy slightly below the muon rest mass (104.97 MeV). The calorimeter should confirm that the candidates reconstructed by the extremely precise tracker system are indeed conversion electrons while performing a powerful μ/e particle identification.
The baseline version of the calorimeter is composed by two disks of inner filled by 1348 pure CsI crystals of 20 cm length. Each crystal is readout by two large area custom SiPMs. We translate the calorimeter requirements in a series of technical specification for the photo sensors that are summarized in the following list: (i) a good photon detection efficiency (PDE) of above 20%, for wavelengths around 310 nm to well match the light emitted by the un-doped CsI crystals; (ii) a large light collection area that in combination with (i) provides a light yield of above 20 p.e./MeV; (iii) a fast rise time; (iv) a narrow signal width to improve pileup rejection; (v) a high gain and (vii) the capability of surviving in presence of 1 Tesla magnetic field, operating in vacuum and in the harsh Mu2e radiation environment. Our solution to all of this is an array of large area UV extended Silicon Photomultipliers (SiPM) connected in series configuration.

Summary

A "custom" modular SiPM layout has been chosen to enlarge the active sensor area and maximize the number of collected photoelectrons from the crystal. To well match the wavelength of the emitted light produced by the CsI crystals the SiPMs have to be extended in the UV region. A configuration in series has been chosen to overcome the issues related to the parallel connection which might affect the energy and time measurements, as due to the very large capacitance that may result in an increased noise, signal rise time and width. The design, production and tests on these SiPMs will be shown.

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