

Pre-production and quality assurance of the Mu2e Silicon Photomultipliers

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The Mu2e calorimeter is composed by two disks of 1348 un-doped parallelepiped CsI crystals of $34 \times 34 \times 200 \text{ mm}^3$ dimension, each one readout by two large area SiPM arrays.

We translated the calorimeter requirements in a series of technical specifications for the SiPMs that are summarized by the following list:

- (i) a high gain, above 10^6 , for each monolithic (6×6) mm^2 SiPM cell;
- (ii) a good photon detection efficiency, PDE, of above 20% at 310 nm to well match the light emitted by the un-doped CsI crystals;
- (iii) a large active area that, in combination with the PDE, could provide a light yield of above 20 p.e./MeV;
- (iv) a fast rise time and a narrow signal width to improve time resolution and pileup rejection;
- (v) a Mean to Time Failure (MTTF) of $O(10^6)$ hours;
- (vi) and a good resilience to neutrons for a total fluency up to $10^{12} \text{ n(1 MeV}_{\text{eq}})/\text{cm}^2$.

A modular and custom SiPM layout has been chosen to satisfy these requirements. To well match the wavelength of the emitted light produced by the CsI crystals, the SiPM detection efficiency have been extended in the UV region. The configuration readout of 2 series of three $6 \times 6 \text{ mm}^2$ monolithic SiPMs has been selected to overcome the issues related to the parallel connection that, due to the large capacitance, could have spoiled the pileup rejection and the energy and time measurements.

A pre-production of 150 Mu2e SiPMs has been procured by three international firms (Hamamatsu, Sensl and Advansid). A detailed quality assurance, QA, has been carried out on each SiPM for the determination of its own operation voltage, gain, quenching time, dark current and PDE. The measurement of the MTTF for a small random sample of the pre-production group has been also completed as well as the determination of the dark current increase as a function of the neutron fluency. A summary of the techniques used and of the QA characterization of the sensors will be shown.

Has accepted

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