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Design, status and test of the Mu2e crystal calorimeter (12' + 3')

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The Mu2e experiment at Fermilab searches for the charged-lepton flavor violating neutrino-less conversion of a negative muon into an electron in the field of a aluminum nucleus. The dynamics of such a process is well modelled by a two-body decay, resulting in a mono-energetic electron with an energy slightly below the muon rest mass (104.967 MeV). If no events are observed in three years of running, Mu2e will set a limit on the ratio between the conversion and the capture rates, \convrate, of $\leq 6 \times 10^{-17}$(@90% C.L.). This will improve the current limit by four orders of magnitude.

A very intense pulsed muon beam ($\sim 10^{10}\mu/$ sec) is stopped on a target inside a long evacuated solenoid where the detector is located. The Mu2e detector is composed of a tracker, an electromagnetic calorimeter and a veto for cosmic rays externally surrounding the detector solenoid. The calorimeter plays an important role in providing excellent particle identification capabilities and an online trigger filter while aiding the track reconstruction capabilities. It should keep functionality in an environment where the neutron, proton and photon backgrounds from muon capture processes and beam flash deliver a dose of $\sim$ 120 Gy/year in the hottest area. It will also need to work in 1 T axial magnetic field and a 10^{-4} torr vacuum. The calorimeter requirements are to provide a large acceptance for 100 MeV electrons and reach at this energies:

- a time resolution better than 0.5 ns;
- an energy resolution *O*(5%);
- a position resolution of *O(1)* cm.

The baseline calorimeter configuration consists of two disks, each one made of $\sim$ 700 undoped CsI crystals read out by two large area UV extended Silicon Photomultipliers (SIPM). These crystals emit at 310 nm with a large light yield (30 pe/MeV) when coupled in air to the SIPMs and provide a fast response and accurate timing having a time emission of $\tau \sim$ 20 ns. These crystals match the requirements for stability of response, high resolution and radiation hardness. SIPM signals are amplified, shaped and then read out through 200 msps waveform digitizers optically connected to the DAQ system. We present the calorimeter design, the experimental tests and the simulation carried out to prove the validity of the chosen configuration. In particular, we will summarise the results of the test beam with electron beams in the energy range between 80 and 140 MeV and the irradiation program carried out both with crystals and SiPM.

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Session Classification: Detector: R&D and Performance

Track Classification: Detector: R&D and Performance