SCINT 2017 - 14th Int. Conference on Scintillating Materials and their Applications

Contribution ID: **47** Type: **Oral presentation**

Design and status of the Mu2e crystal calorimeter

Monday 18 September 2017 15:30 (15 minutes)

The Mu2e experiment at Fermilab searches for the charged-lepton flavour 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 rate and the capture rate \convrate of $\leq 6 \times 10^{-17}$ (@ 90% C.L.). This will improve the current
limit by four orders of magnitude~\cite{MU2ETDR}.

A very intense pulsed muon beam ($\sim 10^{10} \mu/$ sec) is stopped on a target inside a very long solenoid where the detector is located. The Mu2e detector is composed of a tracker and an electromagnetic calorimeter and an external veto for cosmic rays surrounding the solenoid. The calorimeter plays an important role in providing excellent particle identification capabilities, a fast online trigger filter while aiding the track reconstruction capabilities. It should be able to keep functionality in an environment where the n, p and photon background from muon capture processes and beam flash events deliver a dose of ~ 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:
(a) a time resolution better than 0.5 ns @ 100 MeV;
(b) an energy resolution {\it O(10%)} @ 100 MeV and
(c) a position resolution of 1 cm.

The calorimeter consists of two disks, each one made of 674 pure CsI crystals read out by two large area array 2×3 of UV-extended SiPM 6×6 mm^2. We report here all progresses done for the construction and test of the Module-0 prototype that is an array of 51 pre-production crystals from St.Gobain, Siccas and Amcrys firms. Each crystal has been readout by two pre-production Mu2e SiPMs selected among the ones produced by Hamamatsu, Sensl or Advansid . Each photosensor has been amplified and regulated in bias voltage by means of a FEE custom chip. Final digitization stage is also custom and relies on a 5 ns sampling. The module-0 will be exposed to an electron beam in the energy range around 100 MeV at the BTF (Beam Test Facility) in Frascati. Preliminary results of timing and energy resolution at normal incidence will be shown as well as dependence of response and resolution as a function of the impinging angle.

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Session Classification: Applications

Track Classification: S03_Application 1 (Orals)