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Development of Large-Area Charged Particle Detector with Inorganic Scintillator Plates and Wavelength Shifting Fibers

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Abstract:

We have been developing a new charged particle detector based on inorganic scintillator plats of thickness of 1 mm and wavelength shifting fibers (WLSF) of 0.2 mm in diameter. The WLSF are connected to both plate surfaces optically, which top and bottom fibers attached along to x- and y-axis direction, respectively. The WLSF were used two kinds of fibers, B-3(300)MJ (internal layers) and Y-11(300)MJ (external layers), manufactured by Kuraray Co. Ltd. Y-11 fibers have function to determine hit position width of 10 mm. Then, B-3 fibers determine narrow position less than 0.2 mm in the width of Y-11. The MIP particles deposit typically approximately 1 MeV/mm in inorganic scintillators. A La-CPS(Ce) scintillator, (La_0.75 Ga_0.24 Ce_0.01)_2 Si_2 O_7, emits 36,000 photons/MeV. The photons emitted from top or bottom surface of the scintillator (~15%) enter to each WLSF. After the light absorbs in WLSF as efficiency of 20-30%, red-shifted light transfers to both ends of the fibers as efficiency of 10% by total reflection condition. An attenuation length of WLSF is approximately 1 m, thus arrival photon number decreases to 80-90%. Photomultiplier tubes with ultra-bialkali-cathode have a maximum quantum efficiency of 40%. Therefore, a number of photoelectrons of 30-50 is expected, and it means the number is enough to determine hit positions and the position resolution will be achieved less than 0.05 mm. As experimental setup, on the e+ beam line in Research Center of for Electron Photon Science and on the proton beam line in National Institute of Radiological Sciences, trigger counters put on upstream and downstream of the detector, which the trigger consists of plastic scintillating fibers with 0.2 mm diameter. As an initial result, the position resolution was measure in comparison with incident position and reconstructed position. The detector is expected a higher position resolution and lower cost for production than drift chamber. This study provides a possible of spectrometer system without gas detectors in high energy physics using high rate data acquisitions.