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A Balloon Borne Spectrometer for Measuring Positron/Electron Spectra at the TeV Scale

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A future balloon borne spectrometer will be described. The goal of the experiment is to measure the cosmic ray positron and electron flux up to the TeV scale. In the quest for dark matter, the positron fraction in cosmic rays is a key observable as it might indicate the presence of decaying dark matter particles. A balloon spectrometer offers a cost effective method to measure the spectrum with high precision using a simple tracker, magnet, ToF and calorimeter configuration. The electromagnetic calorimeter is a critical component for any balloon based cosmic ray spectrometer for both energy resolution and also background rejection. The development, fabrication and testing of a novel sampling calorimeter will be presented. The design is a lead-scintillator sandwich with wavelength-shifting fibres embedded into segmented scintillator plates. Fibres are read-out with different Silicon-PMTs on each end - Hamamatsu MPPCs and Zecotek MAPDs. The Zecotek device benefits from 15000 pixels/mm2 giving a higher saturation tolerance, but also reduced gain. By utilising both types of Si-PMTs the dynamic range of the calorimeter can be complete from MIPs up to the TeV energy scale for positrons. The design concept offers an energy resolution of 15%/sqrt(E) and proton rejection up to 104. A 16 layer 400mm x 400mm prototype calorimeter has been constructed. Extensive testbeams were carried out at CERN during summer 2012 covering the energy range 0.5 - 180 GeV both proton and electron incident particles. First results in terms of energy resolution, uniformity and potential proton rejection/electron identification efficiency will be presented. Potential physics reach of a balloon spectrometer beyond PAMELA, FERMI-LAT and AMS-02 will also be discussed.

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