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Design and testing of a BGO-SiPM based electron beam dispersion monitor

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A novel position-sensitive electron detector has been developed, which is able to detect each electron in a dispersed beam individually using silicon photo-multipliers (SiPMs) technology. SiPMs consist of an array of Geiger-mode Avalanche Photo-Diodes (APDs). When the APDs are operated in Geiger-mode, i.e. with the applied reverse voltage being greater than the breakdown voltage of the diode, the APDs produce large gain such that they can be used to detect light at very low intensities i.e. small numbers of photons, and, in fact they can even detect single photons. These low photon intensities that are detected by SiPMs match the intensities of scintillation light that is produced by the passage of a single electron through a BGO scintillator. Therefore SiPMs can enable detection and counting of the scintillation photons. The geometrical layout of detector consists of a single BGO crystal with two regular equal and parallel octagonal faces and a thickness of 6mm. The radius of the circle inscribed in the regular octagonal perimeter of the octagonal surface of the scintillator is 17mm. On each of the 8 rectangular faces of the scintillator is mounted a pair of SiPMs. The electron beam position is reconstructed by the differential amounts of photons recorded by the SiPMs. Different algorithms for the reconstruction have been used. The design and performance of the detector is discussed.

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