Development of a Thin and Inexpensive Open-Air Proton Beam Detector for Characterizing the Beam Profile and Position

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The popularity of proton beam therapy in treating cancer is increasing, and further development of beam detectors is necessary to monitor the beam profile and perform quality assurance. The research objective was to construct an inexpensive microstrip gaseous chamber detector using open air as the gaseous volume instead of the currently used multiwire proportional chamber in order to allow decreased thickness, cost reduction, and convenience. A three-dimensional model of the detector geometry was generated in computer aided design software and subsequently finite element analysis was used to simulate electric fields. Final specifications were determined and sent to be custom manufactured on printed circuit boards. Four experimental trials were conducted at a proton beam therapy center to determine the accuracy and precision of the detector in characterizing the beam. In addition, cathode voltage was varied to determine the optimal configuration. The beam diameter was determined to be on average within 0.198 mm of the true value, which is better than the proton beam center's criteria of within 0.4 mm accuracy. The detector precisely measured the center of the beam, although accuracy could not be determined. The detector's resolution was 0.176 mm. The signal-to-noise ratio was optimized by increasing cathode voltage until sparking was observed. These initial data confirm the detector's functionality in measuring the beam. Potential applications of this detector include use as a basic beam monitor, use by medical physicists for convenient quality assurance, or possibly in charged particle detection experiments.

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