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New beam test results of 3D pixel detectors constructed with poly-crystalline CVD diamond

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Detectors based on Chemical Vapor Deposition (CVD) diamond have been used extensively and successfully in beam conditions/beam loss monitors as the innermost detectors in the highest radiation areas of Large Hadron Collider (LHC) experiments. For future experiments at CERN it is expected that the innermost detectors will accumulate an order of magnitude larger fluence than present experiments. This trend of increasing required radiation tolerance is now common in areas where sources and beams are developed with higher energy or higher intensity to reach new regimes of physics. As a result an enormous effort is ongoing to find detector materials that operate after fluences of >10ˆ{16} particles/cmˆ2.

Diamond is one candidate for such a material primarily due to its large displacement energy which enhances its inherent radiation tolerance. Over the last two years the RD42 collaboration has constructed a series of 3D pixel detectors using CVD diamond as the active material and laser fabricated columns in the bulk and characterized them in test beams. This article presents beam test results of 3D pixel detectors fabricated with poly-crystalline CVD diamonds. The cells of the devices had a size of 50 um x 50 um with columns 2.6 um in diameter. The cells were ganged in a 1 x 5 and 3 x 2 pattern to match the layouts of the pixel read-out electronics currently used in the ATLAS and CMS experiments at the Large Hadron Collider, respectively. In beam tests, using tracks reconstructed with a high precision tracking telescope, a tracking efficiency of 99.3% was achieved. The efficiency of both devices plateaus at a bias voltage of 30V. In addition to the test beam results, the effects on charge collection in poly-crystalline CVD 3D diamond pixel devices due to radiation will be discussed leading to methods for achieving a device capable of operating at 10ˆ{17} particles/cmˆ2 .

Submission declaration

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Primary authors: KAGAN, Harris (O); TRISCHUK, William (University of Toronto (CA))

Presenter: KAGAN, Harris (O)

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