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Diamond detector technology; status and perspectives

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At present most experiments at the CERN Large Hadron Collider (LHC) are planning upgrades in the next 5-10 years for their innermost tracking layers as well as luminosity monitors to be able to take data as the luminosity increases and CERN moves toward the High Luminosity-LHC (HL-LHC). These upgrades will most likely require more radiation tolerant technologies than exist today. As a result this is one area of intense research. Chemical Vapor Deposition (CVD) diamond has been used extensively and successfully in beam conditions/beam loss monitors as the innermost detectors in the highest radiation areas of essentially all LHC experiments. The startup of the LHC in 2015 brought a new milestone where the first diamond pixel modules were installed in an LHC experiment (ATLAS) and successfully began taking data. As a result, this material is now being discussed as a possible sensor material for tracking very close to the interaction region and for pixelated beam conditions/beam loss monitors of the LHC/HL-LHC upgrades where the most extreme radiation conditions will exist.

The RD42 collaboration at CERN is leading the effort to use CVD diamond as a material for tracking detectors operating in extreme radiation environments. During the last three years the RD42 group has succeeded in producing and measuring a number of devices to address specfic issues related to use at the HL-LHC. We will present status of the RD42 project with emphasis on recent beam test results. In particular we present the latest results on material development, the most recent results on the independence of signal size on incident particle rate in poly-crystalline CVD diamond pad and pixel detectors over a range of particle fluxes up to 20 MHz/cmˆ2 measured, and results from first 3D diamond detectors which produce an extremely radiation tolerant device and collect nearly all of the charge deposited in the material. In addition we will present plans for future use of the most recent devices.

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