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Diamond Detector Technology: Status and Perspectives

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Here could be your abstract ;-)

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1. Introduction

The upgrade of the Large Hadron Collider (LHC) to the High Luminosity LHC (HL-LHC) from 2023 to 2025 [1] will push the luminosity limits even above the original design values of the LHC and will therefore hopefully give us even more insights in the fundamental nature of the universe. The in 2028 aspired instantaneous luminosity of $5 \times 10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ is equivalent to a fluence of $2 \times 10^{16}\,\mathrm{n_{eq}/cm^2}$ [2] for the innermost tracking layer at a distance of $\sim$30 mm from the interaction point. In this environment pixel hit rates of $3\,\mathrm{GHz/cm^2}$ are expected. The current pixel detectors are designed to withstand $\sim$300 fb^{-1} and thus the full detector would have to be replaced about every semester. This fact lead to research and development of various radiation hard detector designs and materials.

Its large displacement energy and the high band gap (5.5 eV at 305 K) make diamond an excellent candidate for such a radiation tolerant detector which is why the RD42 Collaboration is investigating single-crystal and poly-crystalline Chemical Vapour Deposition (CVD) diamond as an alternative for precision tracking detectors for over two decades. In various studies it was found out that diamond is minimum three times more radiation hard [3], has at least a two times faster charge collection [**?**] and its thermally conductivity is four times higher [**?**] than corresponding silicon detectors.

List of Acronyms

LHC Large Hadron Collider

HL-LHC High Luminosity LHC

CVD Chemical Vapour Deposition

References

[1] G Apollinari, I Béjar Alonso, O Brüning, M Lamont, and L Rossi. *High-Luminosity Large Hadron Collider (HL-LHC): Preliminary Design Report*. CERN Yellow Reports: Monographs. CERN, Geneva, 2015.

[2] Georg Auzinger. Upgrade of the CMS Tracker for the High Luminosity LHC. Technical Report CMS-CR-2016-268, CERN, Geneva, Oct 2016.

[3] Wim de Boer, Johannes Bol, Alex Furgeri, Steffen Müller, Christian Sander, Eleni Berdermann, Michal Pomorski, and Mika Huhtinen. Radiation hardness of diamond and silicon sensors compared. *physica status solidi (a)*, 204(9):3004–3010, 2007.