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Investigation of 3D Diamond Tracking Detectors for Timing application with TCAD tools

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In view of the HL-LHC upgrade the use of Chemical Vapor Deposited (CVD) diamond has been proposed as an efficient alternative to conventional silicon-based devices [1]. Diamond detectors are more robust to radiation damage, the high carriers mobility allows faster signal collection when compared to silicon, while retaining extremely low leakage currents. This could be of particular interest in particle detection applications where stringent timing and radiation tolerance requirements need to be fulfilled. A suitable implementation of such a class of detector is that of 3D pixelated CVD diamond with graphitic parallel columns/trenches contact scheme, fabricated through a focused laser beam technology [2]. TCAD simulations can be exploited to assess the effect of different electrode configurations and/or biasing scheme on the electric field profiles, aiming at minimizing the effects of inefficient field regions in terms of charge collection. For timing application purposes, the effects of a single particle hit have been accounted for by means of realistic time and space descriptions of the energy deposition along its path. Figure 1 shows the simulated transient response of 3D diamond detectors taking into account different particle impact positions.
The transport effects along the graphitic columns can be accounted for, aiming at evaluating the performance and limitations of such a class of detectors. The equivalent "load"effect of graphitic columns of different size/resistivity can be taken into account by means of device-circuit-level simulations including measured resistances and capacitances.
This work is being carried out within the framework of the Italian INFN experiment TIME and Space real-time Operating Tracker (TIMESPOT).

ATTACHED FIGURE

Figure 1. 3D diamond detector time-response comparison for different particle impact positions.
REFERENCES

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