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Comparative time resolution and field uniformity study of single cell 3D pixel structures after neutron and proton irradiation up to 1e17 neq/cm2 at 120 GeV SPS beams

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The proven radiation hardness of silicon 3D devices up to fluences of $1 \times 10^{17}\, n_{eq}/cm^2$ makes them an excellent choice for next generation trackers, providing $< 10\,\mu m$ position resolution at a high multiplicity environment. The anticipated pile-up increase at HL-LHC conditions and beyond, requires the addition of < 50 ps per hit timing information to successfully resolve displaced and primary vertices. In this study, the timing performance, uniformity, and efficiency of neutron and proton irradiated single pixel 3D devices is investigated. Three different geometrical implementations are evaluated for fluences up to $1 \times 10^{17}\, n_{eq}/cm^2$ at 120 GeV SPS pion beams. The question of electronic bandwidth is also addressed, with respect to achievable time resolution, efficiency and collected charge. In such a tri-dimensional phase-space, an appropriate operating point is selected depending on the application requirements. A MIMOSA26 type telescope is used to provide detailed tracking information with a ˜5 μm position resolution. Productions with single- and double-sided processes, yielding active thickness of 130 and 230 μm respectively, are studied, with pixel sizes that vary from $55 \times 55\,\mu m^2$ to $25 \times 100\,\mu m^2$. A comparison of field uniformity with respect to electrode geometry is presented, as well as a time resolution study for incidence angles up to 12°.

Submission declaration

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