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3D single pixel time resolution and uniformity after proton and neutron irradiation of 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 1×10^{17} n_{eq}/cm^2 makes them an excellent choice for next generation trackers, providing < 10 μm 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 discussed. Fluences up to 1×10^{17} n_{eq}/cm^2 in three different geometrical implementations are evaluated using 120 GeV SPS pion beams. 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 examined with varied pixel sizes from 55×55 μm^2 to 25×100 μm^2 and a comparative study of field uniformity is presented with respect to electrode geometry. The question of electronics bandwidth is extensively addressed with respect to achievable time resolution, efficiency and collected charge, forming a tri-dimensional phase space to which an appropriate operating point can be selected depending on the application requirements.

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