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Fabrication and first full characterisation of timing properties of 3D diamond detectors

Very high luminosity experiments at future accelerators will need a new generation of vertex detectors able to stand exceptionally high levels of radiation and to provide precise spatial and time reconstruction of tracks. Diamond sensors may provide a promising radiation hard solution to these challenges posed by future hadron machines.
A 3D geometry with thin columnar resistive electrodes orthogonal to the diamond surface is expected to have enhanced radiation hardness, providing at the same time significantly better space and time resolution with respect to the extensively studied planar diamond sensors.
We report on the development, production, and characterisation of innovative 3D diamond sensors with electrodes obtained by laser nanofabrication, achieving 30% improvement in both space and time resolution with respect to sensors from the previous generation.
This is the first complete characterisation of the time resolution of 3D diamond sensors and combines results from tests with laser, β rays and high energy particle beams.
Plans and strategies for further improvement in the fabrication technology and readout systems as well as results from detailed sensor simulations are also discussed.

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