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Timing detectors with scCVD diamond crystals: the CMS Precision Proton Spectrometer timing system.

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The intrinsic characteristics of CVD diamonds, their superior radiation hardness and the thermal properties make of them an ideal candidate for a timing and/or position detector operated in harsh condition, where high irradiation is foreseen or where appropriate cooling of the sensor surface is undesirable or impractical. Moreover, their fast response to the passing particle make them suitable for high rate environment. Different custom geometries can be implemented for the electrodes through metallization or graphitization in both planar and 3D architectures. The CMS Proton Precision Spectrometer (PPS) consists of 3D silicon tracking stations, measuring both the position and direction of protons scattered in the very forward region, as well as timing detectors based on planar single crystal CVD diamond, measuring the proton time-of-flight with high precision. The detectors are hosted in special movable vacuum chambers, the Roman Pot, which are placed in the primary vacuum of the LHC beam pipe. Detectors have to operate in a vacuum at few mm from the primary LHC beam and must be able to sustain and highly non-uniform irradiation, with local peak above $10^{16} neq/cm^2$. In this presentation, after an introduction to the diamond technology, we will describe the PPS timing system. The sensor architecture, with two diamond sensors read out in parallel by the same electronic channel, the dedicated amplification chain and the strategies used to digitize the signals will be described. Latest results on the timing detector performance during LHC Run 2, in terms of efficiency and time precision, will be reported. Timing detectors used in Run 2 have been dismounted and tested for efficiency and timing performance. The final results, here reported, are important to understand the effect of the radiation on such devices. The ongoing upgrades and consolidation activities for the upcoming LHC Run 3 will be finally discussed.

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