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CMS Central Beam Pipe Instrumentation with Fiber Bragg Grating Sensors: Two Years of Data Taking

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We present the recent results of the monitoring of the central beam pipe of the Compact Muon Solenoid Experiment (CMS), at the European Organization for Nuclear Research (CERN). The measurements are carried out by means of an innovative fiber optic monitoring system based on the Fibre Bragg Grating (FBG) sensor technology. The CMS central beam pipe is part of the Large Hadron Collider (LHC) and is the place where the high energy LHC collisions take place. It is made of a beryllium tube section, 3m long with a central diameter of 45mm and 0.8mm thickness wall, sealed on the two extremities with two conical aluminium sections, each 1.5m long. Being spectrally encoded, the FBG sensors are insensible to electromagnetic interference, intensity modulation of the optical carrier and broadband-radiation-induced losses. Hence, fiber optic monitoring system based on FBG sensors represents the ideal solution to achieve a reliable and accurate sensing system to be used 24/7 in the harsh environment in the CMS experimental facility.
Our monitoring system consists of four polyimide coated SMF28 fibers (200μm diameter: core-cladding-coating) placed along the cardinal longitudinal positions on beam pipe cross section. On each fiber, 16 FBGs have been manufactured: 7 are solidary glued on the pipe to measure the local strain and the remaining 9, are left unglued but in contact with the pipe in order to work as local thermometers and as temperature compensators for the adjacent strain sensors.
The mechanical complexity of the structure will be described and the first temperature and strain measurements data recorded during the LHC operations will be discussed. The data recorded have proven the overall sensitivity and reliability of this innovative monitoring system. The designed system allows the monitoring of any deformation induced on the CMS central beam pipe during the detector motion in the maintenance periods and magnetic field induced deformation during operation phases. Moreover, the temperature FBG sensors represents a unique solution to monitor the beam pipe thermal behaviour during the various operational and maintenance phases. This innovative solution will be a milestone for beam pipe monitoring in high energy physics.

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