Contribution ID: **577** Type: **Poster Presentation (120m)**

Qualification of 0-60 mbar pressure transducers for the LHC HL-LHC environment at CERN

Wednesday 24 July 2024 14:00 (2 hours)

The LHC (Large Hadron Collider) upgrade (HL-LHC) at CERN, requires the procurement of 0-60 mbar absolute pressure sensors with an absolute accuracy of +/- 0.3 mbar and a radiation Total Integrated Dose (TID) that may reach 100 kGy. Unfortunately, commercial sensors with embedded electronics cannot be used due to the effort required for qualifying electronics for radiation environments. Such a low-pressure range is usually measured through the deformation of a relatively large diaphragm and the sole passive sensors available commercially use magnetic coupling for the measurement of the deformation. An industrial partner, ABB© provided CERN with their low-pressure measuring cell that is based on a piezo resistive bridge measuring the diaphragm deformation. This cell is used in their commercial device that, apart from the radiation requirements, is compatible with the accuracy requirements. In radiation environments, 0-100 mbar pressure sensors have been installed and operated successfully in CERN's accelerators complex (LHC and SPS), the sensors being manufactured respectively by NICHE© (not anymore available) and the ABB© passive cell.
A radiation qualification test was performed with a gamma source targeting a 100 kGy TID. The sensors under test were a Valydine© DP10 and an ABB© passive pressure cell. The pressure sensors were attached to a leak-tight sealed cell, the cell temperature can be adjusted and therefore the pressure followed the perfect law of gases.
The paper presents the radiation measurement set-up, the readout electronics located in a radiation-free location and the results of the irradiation. The sole sensor capable of withstanding the HL-LHC upgrade TID requirements is the Validyne© sensor that is not sensitive to ambient temperature variations but for which the cable is part of the sensor impedance.

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Session Classification: Wed-Po-2.4

Track Classification: Tracks ICEC 29 Geneva 2024: ICEC 11: Instrumentation and process control