



Contribution ID: 125

Type: **Poster Presentation of 1h45m**

New Bridge Temperature Sensor for Superconducting Magnets and other Cryogenic Applications

Thursday 31 August 2017 13:45 (1h 45m)

A few hundred temperature sensors are used to control the temperature behaviour of the gigantic ATLAS toroid superconducting magnet system during cool down and normal operation. In order to guarantee good sensitivity of temperature measurements in the range from liquid helium to room temperature, two types of sensors are positioned at the same location: platinum resistance thermometers for the range 30-300 K and carbon composition resistors (Allen-Bradley) for the 4 to 30 K range. Both types are very well known for use in cryogenics and they perform nicely during 10 year of ATLAS operation. The sensors are easy available and cheap and the main cost is for the many kilometre of cold and warm instrumentation cables, connectors, conditioners and installation work. A reduction of the amount of measurement channels is an important issue and this motivated us to develop a new compact and robust sensor module covering the entire temperature range that would combine advantages of both platinum and carbon resistors. The solution is trivial, elegant and simple. Two resistors with positive temperature derivative and two resistors with negative temperature derivative are connected in a full bridge connection. We used two platinum and two carbon resistors. The output signal is a result of the subtraction of voltages across positive and negative temperature derivative resistors that makes this temperature bridge sensor very sensitive for the entire temperature range. Variable temperature characterization tests were performed in helium gas environment in the CERN Cryogenic Laboratory. The bridge sensors have shown a full range sensitivity better than 0.1 mV/K at a supply current of 100 μ A. In the meantime a few other superconducting detector magnets in experiments operating at CERN are equipped with these new simple and robust temperature sensors.

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Session Classification: Thu-Af-Po4.11

Track Classification: G8 - Novel Diagnostics and Other Techniques