Radiation hardness of pressure sensors for 0-100 mbar range

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Indico link: https://indico.cern.ch/event/760345/
Sensor overview

- ABB 266AST 0-60 mbar absolute sensor
- Same technology for differential and gauge sensors up to 600 bar
- ABB piezoresitive sensor with a bridge
- Stripped from any electronics
- Originally thermodiode for temperature compensation
- PT1000- additional sensor (radiation resistant)
- Active sensor: 0.04% or 0.025%
- Passive with cable: ~0.3%
Additional PCB

- D0 is originally inside the sensor and cannot be removed
- WordFip card cannot measure bridge with D0 because it measure resistance for positive and negative current and if current is too big it rises error
- In new configuration measurement for negative current gives $V_{out}=0$ and not affect measurement significantly
First radiation test - Charm

- Two sets with sensors
- One for 3 weeks
- Second for 2 weeks
- Pressure changed by temperature according to $nRT = pV$
- Radiation $\sim 3.57\text{Gy/h}$
- Total dose 1800 Gy
Charm setup

- EPS for thermal insulation
- Sensor
- Piping for Volume
- Electrical connection
- Resistor heater with fan for distributing heat
- Valve: closed and with cap at the end

11-12 December 2018 R2E Annual Meeting
CHARM results

• Not stable pressure reference spoiled results. Probably because of leakage or outgasing. Outgasing would explain non ideal gas behavior
• But sensor is still better than 2% with ~1800Gy which is probably better
Second radiation - Co60

- Two ABB in front of Co60 - 55.88 Gy/h
- One ABB very close but out of radiation area – 25 mGy/h
- Low pressure test bench and MKS baratron reference outside radiation room
- Testing full range 0-60 mbar but in stable temperature 22.5°C
Co60 setup

Radiated sensors

Test bench with MKS baratron reference

Reference ABB

Acquisition
Error against received dose

- Error vary for different pressure
- Both sensor behaves similar but one is almost symmetric and another has bigger error close to 0 mbar
- Asymmetry and nonlinearities may be result of conditioning by third degree polynomial
- Polynomial depends with temperature but in this test it was stable enough
Co60 comparison to reference

- Total dose: 11.47 kGy with dose rate: 55.88 Gy/h
- Error increased from ~0.2% -> ~1.1%
- Error function could be more less approximated by line
- Error stays constant when radiation is terminated
Co60 thermodiodes

- Thermodiodes used originally for temperature compensation cannot be used for reliable temperature measurement in radiation
- Diodes saturate with dose but still error is enormous
- Error stays constant after stopping radiation
Conclusions

• ABB pressure sensors can be used in high LHC radiation but with limited accuracy
• To achieve sufficient accuracy it is needed to add another temperature sensor e.g. PT1000
Questions