Radiation hardness of pressure sensors for 0-100 mbar range

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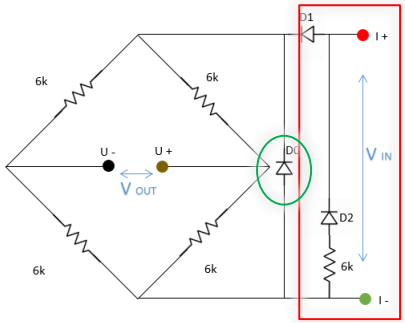
Indico link: https://indico.cern.ch/event/760345/

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
- Striped 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 Vout=0 and not affect measurement significantly



First radiation test - Charm

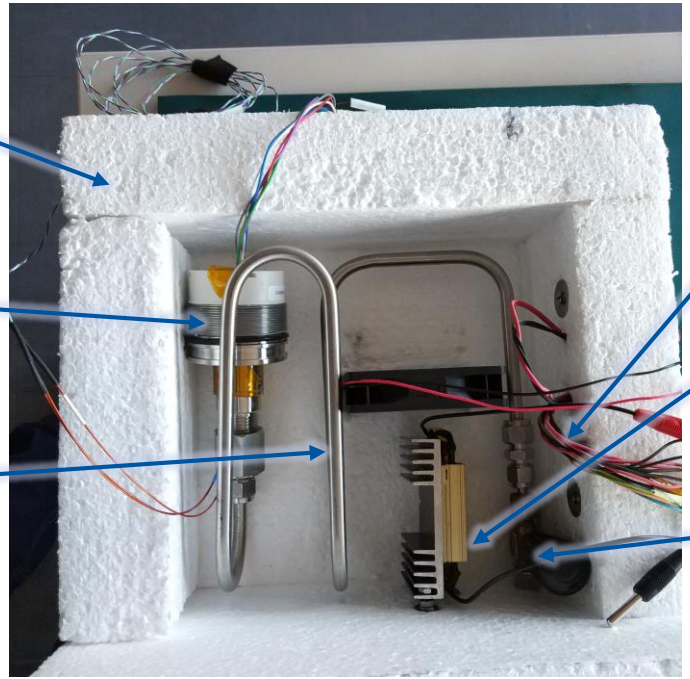
- Two sets with sensors
- One for 3 weeks
- Second for 2 weeks
- Pressure changed by temperature according to nRT=pV
- Radiation ~3.57Gy/h
- Total dose 1800Gy

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

CHARM results

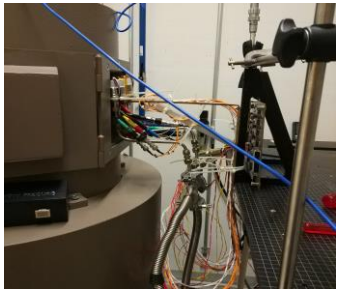
- Not stable pressure reference spoiled results. Probably because of leakage or outgasing. Outgasing would explain non ideal gas behavior
- But sensor is still better than 2% with ~1800Gy which is probably better

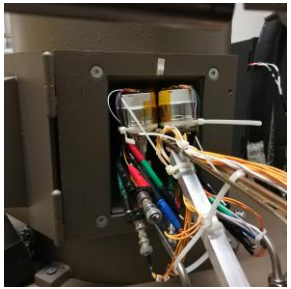
Second radiation - Co60

- 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

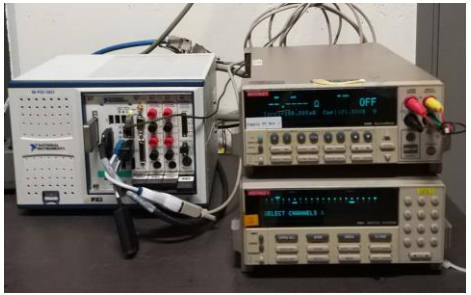
Radiated sensors





Reference ABB

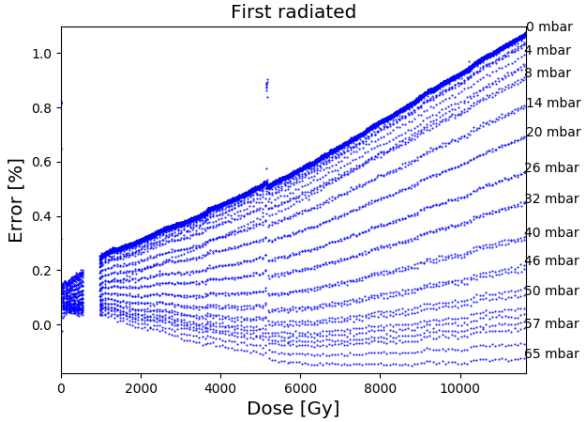
Test bench with MKS baratron reference

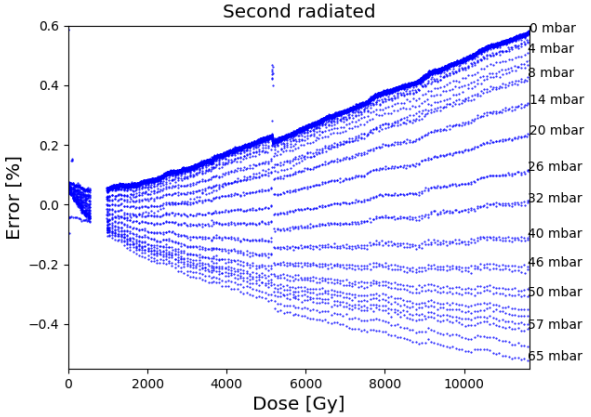


Acquisition

Error against received dose

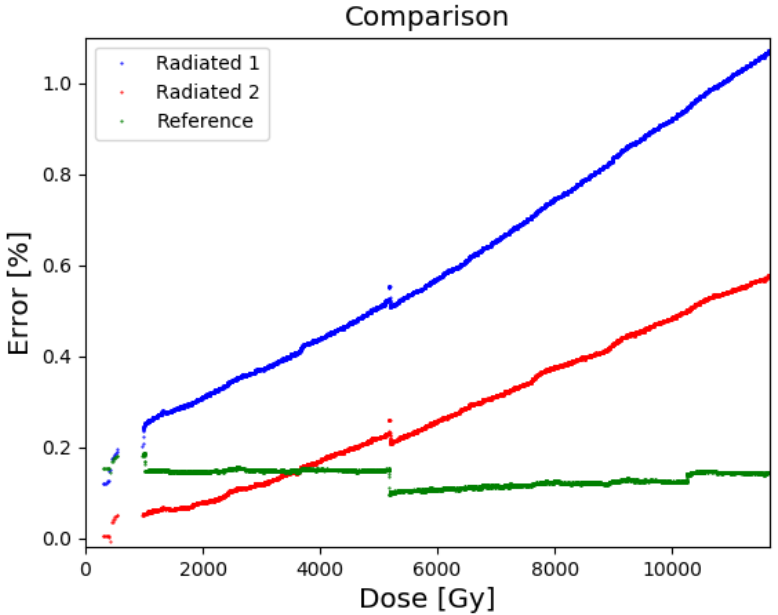
- Error vary for different pressure
- Both sensor behaves similar but one is almost symmetric and another has bigger error close to 0 mbar
- Asymmetry and nonlinearities may be result of conditioning by third degree polynomial
- Polynomial depends with temperature but it this test it was stable enough





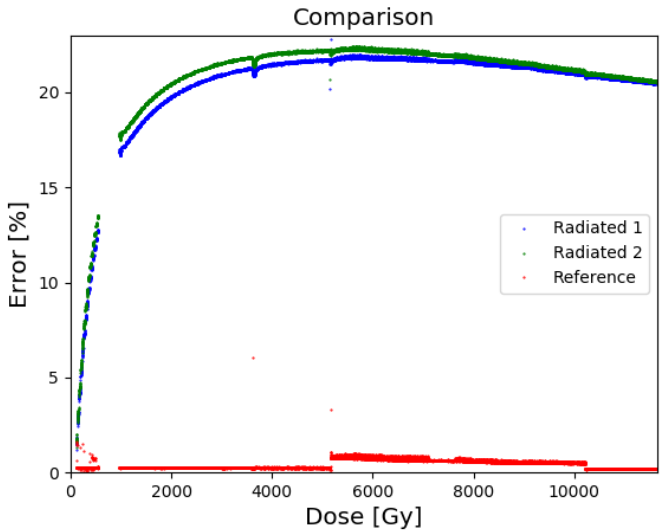
Co60 comparison to reference

- 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