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AGEING TESTS OF HV BOARDS AND GLUES IRRADIATED WITH NEUTRONS

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Abstract

We report on the ageing tests of an HV board and of samples of glues which have been irradiated with fast neutrons. No ageing effect has been measured.

1. Introduction

The ageing of a wire tube induced by radiation depends strongly on the kind of pollutant outgassed by the materials in contact with the gas. Therefore it makes sense to verify if the ougassing features are modified if a material undergoes a strong irradiation. The particle which may change more effectively the bulk properties of a material is the neutron. Neutrons can induce reticular displacements (fast neutrons) and nuclear reactions (both thermal and fast neutrons) which change the chemical structure.

Here we report on the ageing tests performed on an HV board and on samples of glues irradiated by neutrons at the Prospero facility in Valduc.

2. Experimental setup and procedure

The experimental setup and method is described in details elsewhere [1]. Here we remind briefly the main features.

We compare the gain of two twin wire tubes. The first tube is used for reference, the second is irradiated with a strong X-ray source to accelerate the ageing process. In between the tube a tank is placed which contains the material under investigation. The clean gas from a premixed bottle (Ar-CO_2 mixture) flows through the reference tube, then

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through the tank where it is polluted by the outgassing material and then through the irradiated tube.

The gain of the two tubes is monitored by measuring the position of the peak of monochromatic X-ray sources with a multichannel analyzer.

To scale the laboratory test with the LHC conditions we remind that the effect is directly proportional to the outgassing surface, to the accumulated charge and inversely proportional to the gas flux. The total charge equivalent to 10 years of operation at LHC in the test is Q_{10} = 4.8 C (at parity of surface and flux). At LHC the gas flux is Φ_{DT} = 0.8 cc/min. Therefore the charge Q_{TEST} accumulated during the test is equivalent to number Y of years in the LHC conditions given by

$$Y = 10 \cdot \frac{S_{TEST}}{S_{DT}} \cdot \frac{Q_{TEST}}{Q_{10}} \cdot \frac{\Phi_{DT}}{\Phi_{TEST}} \qquad (1)$$

where S_{TEST} is the surface of the material in the tank, S_{DT} the surface of the material in a single tube of the muon chamber and Φ_{TEST} is the gas flux in the test.

The HV board equips 8 channels, hence S_{TEST}/S_{DT} = 8. The total dose absorbed by the HV board is $2 \cdot 10^{12}$ neutrons/cm^2.

The glue is located mainly along the I-beams. The amount of glue exposed to the gas can be calculated taking into consideration that the maximum glue thickness is 100 μm and the I-beam length is 250 cm. Therefore $S_{DT,glue}$ = 10 cm^2.

In the test $S_{TEST,glue}$ = 9 cm^2. The glue samples have absorbed a dose of $5 \cdot 10^{10}$ neutrons/cm^2.

3. Results

The dependence of the peak position (in ADC channels) for the irradiated and for the reference tube is monitored as a function of the accumulated charge. Actually what is relevant is the ratio R between the two peaks. R is constant if there is no ageing effect.

3.1 HV board

Fig. 1 shows the dependence of R on the accumulated charge for the HV board. R is constant within the error.

The total accumulated charge Q_{TEST} is Q_{TEST} = 2.06 C while Φ_{TEST} = 1.3 cc/min. The test shows that there is no ageing effect for a period equivalent to 21 years of LHC (from eq.(1)).

3.2 Glues

Fig. 2 shows the dependence of R on the accumulated charge for the test of the glue samples. There is no dependence of R from the accumulated charge.

The total accumulated charge Q_{TEST} is Q_{TEST} = 3.17 C while Φ_{TEST} = 2 cc/min. The test shows that there is no ageing effect for a period equivalent to 2.4 years of LHC (from eq.(1)).

4. Conclusions

We have tested an HV board and the glues used for the barrel muon chambers to verify that the irradiation with neutrons does not change the outgassing properties of the materials. No ageing effect has been measured. Regarding the HV board, the test is equivalent to about 20 years of operation at LHC. For the glues, the test is equivalent to 2.4 years.

References

[1] E. Conti, R. Ballarini, F. Gasparini, *Tests of the wire ageing induced by radiation in the barrel muon chambers of the CMS experiment at LHC,* Proceedings of the RADECS99 conference. Available on web at http://warco.pd.infn.it/cms/ageing.html

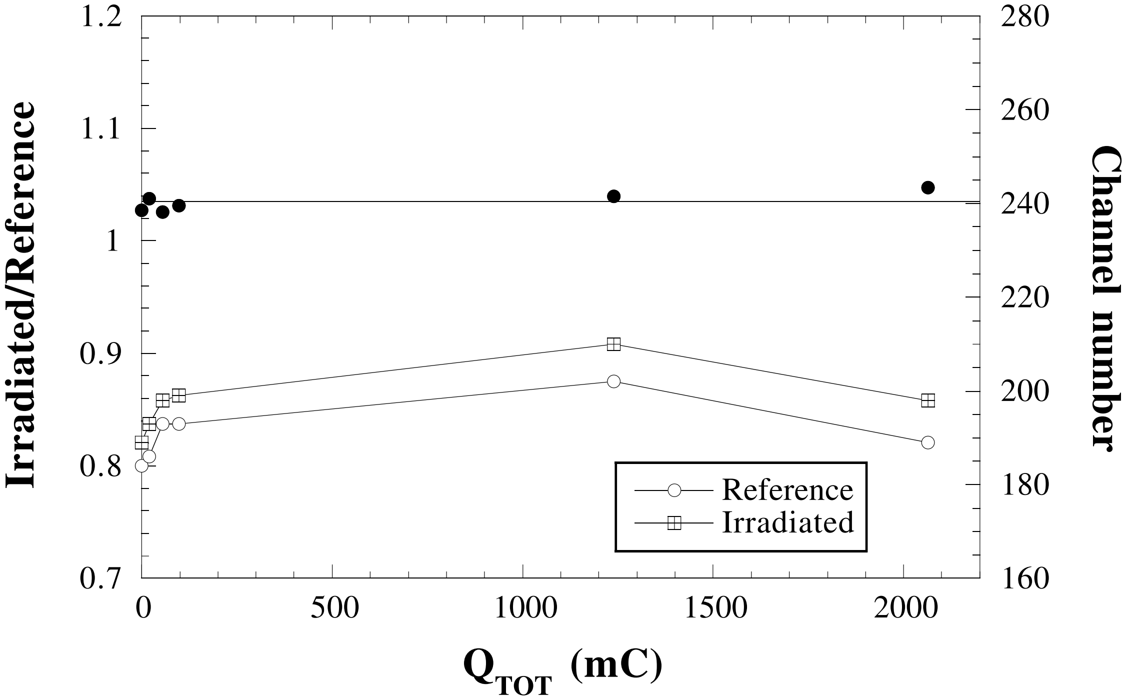

Fig. 1. Test of the HV board. Dependence of the ratio R (closed circles) between the peak position of the irradiated cell (crossed squares) and the reference cell (open circles). The continuos line is the best fit to a constant line.

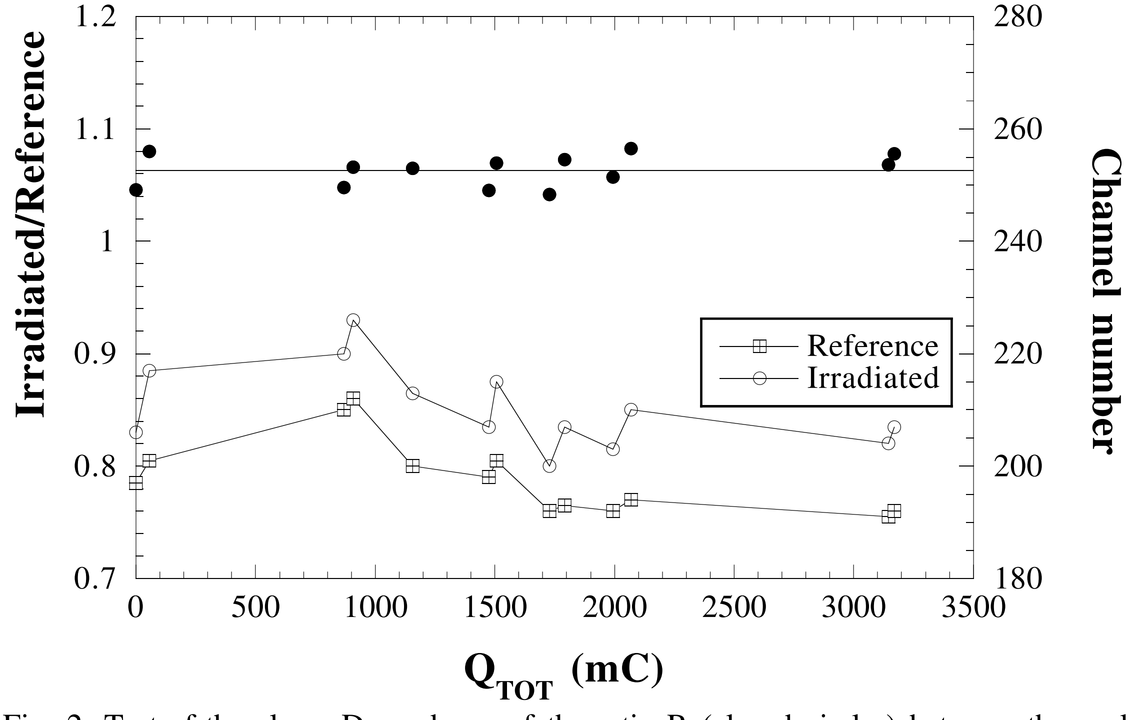

Fig. 2. Test of the glues. Dependence of the ratio R (closed circles) between the peak position of the irradiated cell (crossed squares) and the reference cell (open circles). The continuos line is the best fit to a constant line.