Radiation hardness of electronics for the temperature regulation of the top of current leads

Tests in CNGS

Context

- Cartridge heaters are incorporated inside the top part of each current lead to avoid heavy condensation or ice formation when the current leads are operating at zero current or at a current lower than the nominal one. These heaters guarantee that the temperature at the top of the current lead stays above the dew point.
- The temperature of copper block on the top of current lead is controlled by a regulator which commands a solid state relay. These electronic components are installed in different areas in LHC tunnel like, UA, UJ, RR, USC
- The power units are installed closed to the DFBs are composed of a transformer and a circuit breaker.

Electronic components

For the temperature regulation, the electronic components are chosen in industry according to their technical specification and price

No special requirement related to the radiation hardness







Tests in CNGS in 2008

- 2 control units were installed in CNGS with 2 controllers and 2SSR (25A and 50A)
- First tests occured from the 6th to 20th oct 2008
 - First unit (with SSR 50A): Operationnel until the 11th oct.
 - Hadrons (E>20MeV) = 12.10⁹ cm⁻²
 - Neutrons (E_{eq} 1MeV) = 13.10⁹ cm⁻²
 - Second unit (with SSR 25A) : Operationnel intil the 15th oct.
 - Hadrons (E>20MeV) = 28.10⁹ cm⁻²
 - Neutrons (E_{eq} 1MeV) = 32.10⁹ cm⁻²
 - 2 units stayed in zone until the 20th oct.
 - Hadrons (E>20MeV) = 50.10⁹ cm⁻²
 - Neutrons (E_{eq} 1MeV) = 55.10⁹ cm⁻²

Tests in CNGS in 2009

- In oct 08 the display of the 2 regulators did not work.
- In April 09, the 2 units were tested. The 2 SSR worked perfectly well as well as one of the regulator (from unit 2).
- The regulator of the unit 1 has been replaced and the 2 control units are now in CNGS (TSG46) but not directly exposed in front of the tunnel but slightly protected by the wall.
- According to logging data, on the 18th june
 - Dose (TGS4.CNGS08:Dose_LS) = 0.18 Gy
 - Neutrons (TGS4.CNGS08:Neutrons_HS) = 9.10⁹ cm⁻²

Radiation expected in LHC

I RR17 DYAA01 7 6 1 54 4.E405 9E07 5E408 0.2 1 W17 DYAA01 6 7 6 1 24 4.E405 9E07 5E408 0.2 1 W14 DYAA01 6 7 6 1 28 3.E407 1.E410 1.E411 100. 2 UA23 DYAC01 6 2 32 3.E407 1.E410 1.E411 100. 2 UA23 DYAC01 6 2 3.E407 1.E410 1.E411 100. 2 UA23 DYMC01 1 2 3.2 3.E404 2.E406 7.E406 1.E0 3 U33 DYRE01 11 3 3.3 18 3.E404 2.E406 7.E406 1.E0 3 U33 DYRE01 11 4 3.262 3.E404 2.E406 7.E406 1.E0 4 UA43 DYRE	Point	Location	Rack Name	75 V A	150VA	750VA	1500VA	controllers	2009/10	E≫20MeV	eq 1Meq	Dose
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