

GROUNDING, SHIELDING & COOLING ISSUES ON LHCb ELECTRONICS AT THE LHC PIT 8

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Abstract

The grounding, shielding and cooling issues are important factors in the design, the operation and the maintenance of all the electronics systems. Noise sources in High Energy Physics Experiments are specially taken into account. Inadequate grounding, shielding and/or cooling lead to unreliable operation of the particle detectors because most of them work with very low signal levels.

INTRODUCTION

The LHCb detector is designed to search for New Physics through the study of CP violation in B decays with the precise determination of the CKM parameters at the LHC at CERN. The installation of the experiment started in 2002 was completed, except the muon station 1, in June 2008. The experiment is ready for data taking from August as scheduled. The experimental cavern (ex-DELPHI at LEP), 100 m underground at pit 8 is divided in two main areas. The layout of the experimental area (UX85 cavern) is shown in Fig.1. The detector area (UXB) is separated from the protected area (UXA) by a large radiation shielding wall of 3200 tons of concrete. The UXA area is essentially dedicated to the non-radiation tolerant electronics, such as the DAQ interface electronics and the PC farm of about 2000 computing nodes in its final configuration. The UXA area is always accessible when the LHC operates.

Magnetic Field

The residual magnetic field generated by the large dipole magnet (3.6 Tm, 4.5 MVA, 6.8 kA, 1800 t) was simulated using VF OPERA-3d code. The top view of the magnetic field map around the LHCb detector in the plan of the LHC beam is shown in Fig. 2. The electronics which were specified to be placed closest to the sub-detectors are located in areas below 5 mT in order to avoid the potential problems.

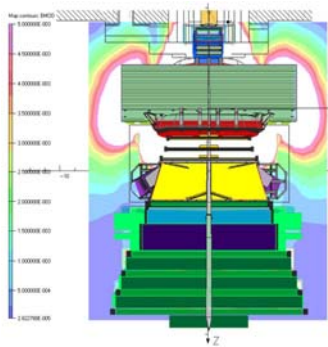


Fig. 2: Magnetic field map in the LHC beam plan

GROUNDING

The first purpose of the grounding is safety. But in addition, in order to reduce the impedances between the sub-detectors and the counting house (80-100 m far away), a high mesh earth network connecting all the metallic structures and all the electrical equipments is adopted for LHCb in UX85. The safety earth cable interconnects all the metallic structures and the electrical equipments to the secondary star points of the main transformers and to the earth cables running both sides the UX85 cavern. The safety earth cables are also connected to the underground LHC machine earth with a connection to the surface where earth electrodes in the ground are available.

COOLING

All the racks located in the counting house are directly cooled with mixed water. The muon, calorimeter electronic racks, IT & TT services boxes are also cooled with mixed water. The IT, TT, RICHs, VELO & OT have their own cooling system using specific coolants such as C6F14. These cooling units are installed in the accessible area (UXA). The specific coolants are supplied to the sub-detectors via transfer lines.

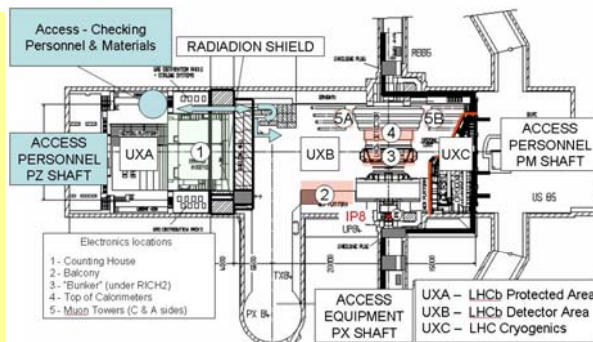
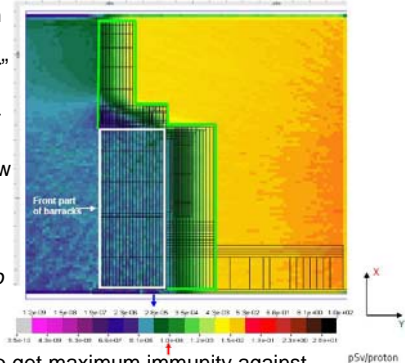


Fig. 1 : Top view of the LHCb experimental cavern

ENVIRONMENTAL CONSTRAINTS

The various locations of the LHCb electronics are schematically shown in Figure 1 (areas noted 1,2,3,4 & 5). The ECS crates nearby the sub-detectors are located at the balcony (VELO, TT, RICH1), at the "bunker" (OT, IT, RICH2, M1) Fig.4, at the top of the calorimeters and inside the muon towers. These places were specified as the best compromise for LHCb. But, the large radiation shielding wall is a real barrier for all services (power, readout, control) which have to pass across via narrow chicanes in order to reach the protected area (UXA). On the detector side, there is two major constraints which are magnetic field and radiation.

Fig.3 : Ambient-dose-equivalent map in the centre of the UX85 cavern



SHIELDING

The shielding of electronic components is needed in order to get maximum immunity against external electromagnetic fields. There are three basic reasons for using shields: against capacitive coupling, against inductive coupling and radio-frequency (RF) environment. The usual way to stop the capacitive coupling is to enclose the circuits or conductors to be protected in a metal shielding box (Faraday shield). The physical mechanism of the inductive coupling is magnetic flux lines from external interference sources, via current loops in the victim circuit, which generates a low voltage component. Changing electrical and magnetic fields may also generate RF interference problems. All signal wires are potential antennas for the reception and/or the transmission of RF noise.



Fig. 4 : Electronics under the "bunker"