



Work Package

Vacuum System for the NOVEC cooling lines of the LHCb SciFi detector

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Vacuum system for the Novec cooling lines of the LHCb SciFi detector

Abstract

The present document describes the terms of the agreement between the LHCb SciFi collaboration and the CERN EP-DT group for the design, assembly, test and commission of the vacuum system for the NOVEC cooling lines for the LHCb SciFi detector during LS2.

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Distribution List

History of Changes

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2	20/03/2018	All	Technical and costing (XP)
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1 Introduction and General Considerations

This document is an agreement between the Detector Technologies Group (EP-DT) and LHCb SciFi. It describes the terms of the agreement and the support provided by EP-DT-DI for the design, assembly, installation, test and commissioning of the LHCb SciFi Vacuum System control system during LS2.

EP-DT CERN personnel that will be involved in supervisory tasks, software generation, commissioning and systems tests is not accounted in this agreement. The first point of contact in EP-DT for this WP is the EP-DT-DI Section Leader, G. Lehmann Miotto.

It is understood that unforeseen situations can require interventions or specific resources that go beyond the scope of the work described in this document. Those will be discussed on an ad-hoc basis.

Some tasks need to be carried out in restricted areas. It is LHCb responsibility to make sure that CERN-RP measures the radioactive levels and ensures compliance with the established dose limits. The intervening EP-DT team shall be informed of the radioactive level before interventions are carried out. ALARA must be applied by means of optimization.

The LHCb SciFi tracker will make use of the mono-phase coolant Novec® to cool the SiPM photodetectors to -40°C. The coolant is refrigerated and pumped to two distribution boxes (side A and C), which will be located in the LHCb bunker. A total of 2 x 12 feed and 2 x 12 return lines (together called the distribution lines) supply the coolant to the 24 Novec manifolds. These are an integral part of the 12 C-frames, which constitute the detector mechanical structure. For performance and space reasons, the 48 distribution lines and the 24 manifolds are vacuum insulated. For this purpose, the distribution lines consist of two concentric corrugated stainless steel tubes of diameter DN16 and DN32, respectively.

The concept and main design parameters are summarized in the LHCb note LHCb-PUB-2017-022. (<https://cds.cern.ch/record/2295263>).

It consists of two pumping groups (turbo molecular pump + scroll pump), one per side, a small number of valves, 26 Pirani pressure gauges (one per manifold + one per pumping group), two DN63 tubes with flexible 24 DN25 connections to the distribution lines. The SciFi Vacuum control system will automatically operate the pumps and valves in automatic and safe mode as well it will assure the readings of the Pirani probes.

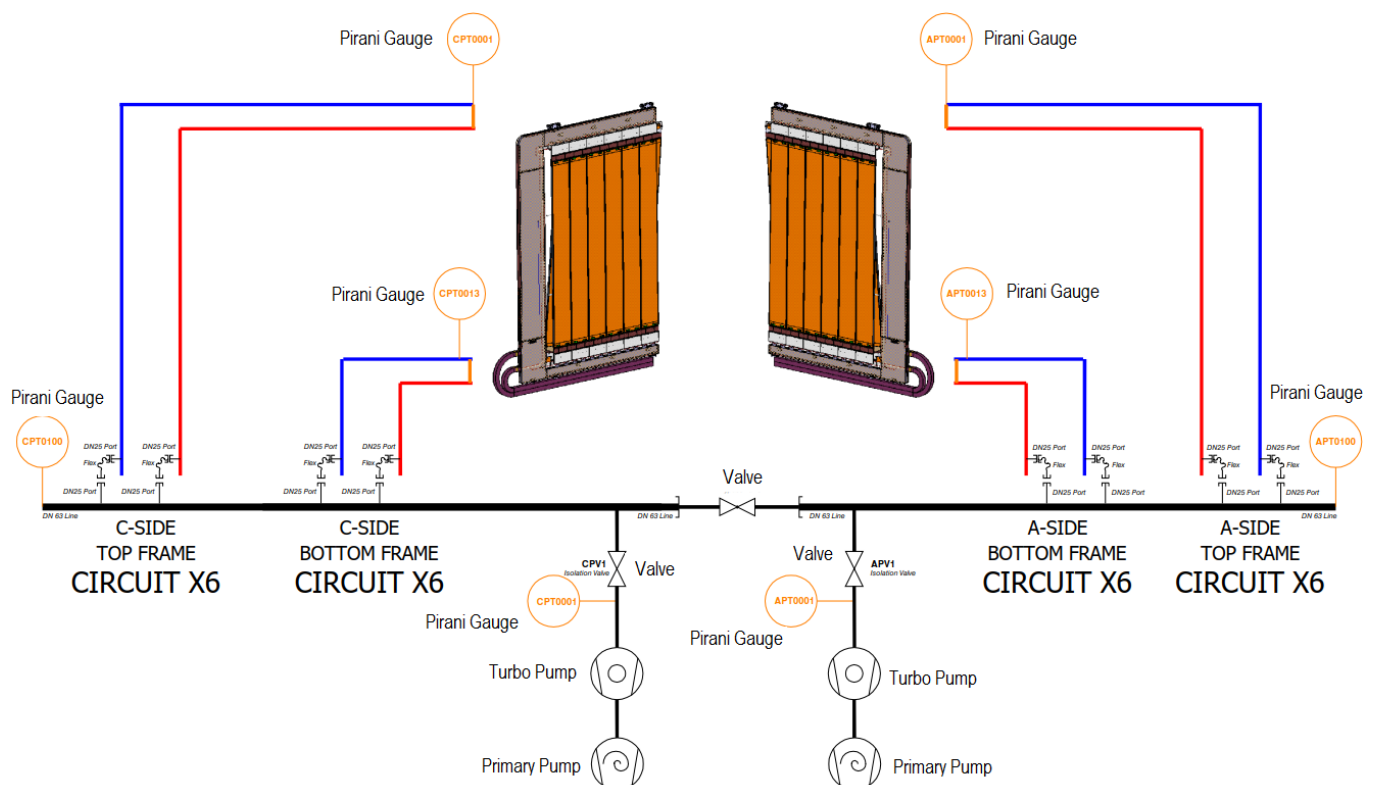


Figure 1 - LHCb SciFi - Vacuum System P&D

The presence of ionizing radiation, cumulating to 50 Gy over the lifetime of the experiment, requires to detach the readout electronics from those Pirani gauges that are mounted on the manifolds and to displace them to the bunker area.

The presence of magnetic field approaching 10 mT in the bunker area requires to place the turbomolecular in a simple magnetic shield (iron cylinder, wall thickness $d=3$ mm, the cylinder length should be at least three times its diameter).

2 The LHCb SciFi Vacuum control system

The Vacuum Control System will be based on Siemens S7-1500 PLC (Programmable Logic Controller) technology commonly used and supported at CERN. The different layers of the control system are shown in the Figure 2.

All the components included in the Field Layer: sensors (vacuum pressure gauges, switches...) and actuators (pumps, valves) will be connected to the PLC (Control Layer) containing the logic control program; executing the proper actions and generating the interlocks according to the defined and programmed conditions.

The PLC control program will follow the CERN BE-ICS control system standards called UNICOS framework which allows the PLC program software connection to the WinCC SCADA software used in the Supervisor Layer (i.e. the SciFi Detector Control System or DCS). The DCS operator will monitor and operate, according to defined rights, the vacuum control system from the LHCb control room. Alarms can be defined and programmed in the control system (PLC-WinCC) taking the proper actions; in addition SMS and e-mail alerts can be setup at the WinCC level. The WinCC software will also archive all the relevant data in the ORACLE database. Furthermore, there is the possibility to connect by remote desktop from outside CERN network to the WinCC SCADA application by means of terminal server connection.

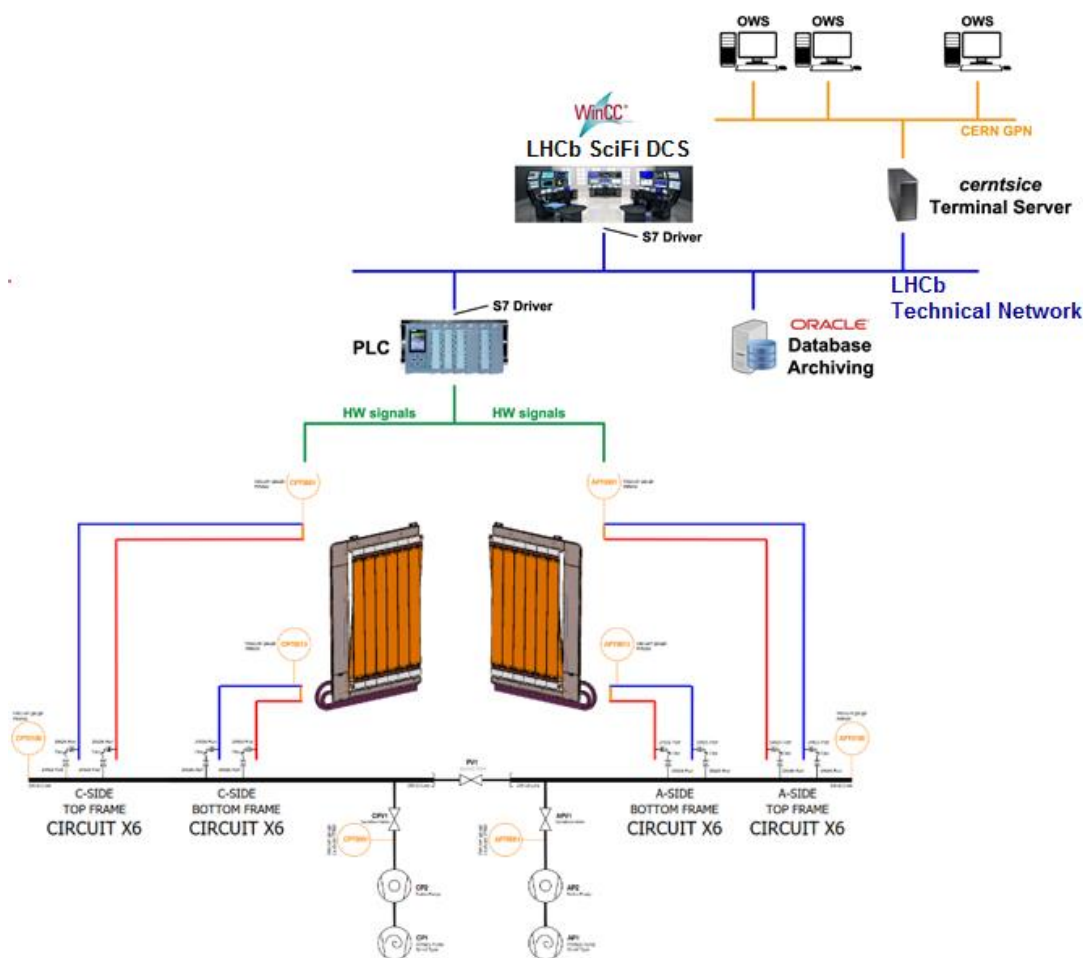


Figure 2 - LHCb SciFi Vacuum Control System layout

The PLC will be installed in a dedicated 19" Rack for the SciFi vacuum system, which will also contains all the control and power circuits as well the connections to all the components of the system. To remark that due to the radiation level, the readout electronics of the Pirani Gauges that are mounted on the manifolds will be displaced to bunker area inside a patch panel.

From spring 2018 to late summer 2019, the SciFi C-frames will be assembled, loaded and tested in the surface hall 3852. This will include the cool down of the SiPMs to -40°C and hence require the presence of a vacuum system for the insulation of up to 4 Novec distribution lines as well as two cold boxes. A minimal control system is also required

3 Cost estimate and schedule

Name	Description	Price
Hardware	Rack	1 500 CHF
Electrical	Power Distribution, 220 Vac, 24 VDCS redundant crate	3500 CHF
PLC	PLC, CPU, I/O modules	6500 CHF
Electrical Devices	Terminal block, breakers...	2000 CHF
Pirani Gauges	30 pieces x 250 CHF	7500 CHF
Patch Panel	Interface crate for Pirani electronics allocation	3500 CHF
IT	PC	1000 CHF
Prototype Control Set-up		2000 CHF
FSU		10000 CHF
		27 500 CHF

This cost estimate assumes that all facilities such as network, UPS and cabling are provided by LHCb.

Includes the hardware connections: pumps, gauges, valve, and patch panel installation however, it does NOT include the cable and/or cable tray installation in the cavern.

The prototype control system shall be in operation by the end of spring 2018

The system shall be fully developed in autumn 2018.

4 Limits of EP-DT responsibility

EP-DT-DI is not responsible for any mechanical or work linked to the SciFi cooling system.

EP-DT-DI will participate the the commissioning and testing of the motion control system but will not be involved in the operations of the latter, nor will it offer any stand-by support. Requests for modifications and improvements will be dealt with on a best effort basis, during working hours.