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Review of the LHCb Addendum to the Muon System Technical Design Report

1 Introduction

This document describes the process and conclusions of the review of the Addendum to the LHCb Muon System TDR. The proposed modifications are required to replace the Resistive Plate Chamber (RPC) detectors. The reason for this change is an ageing effect of the RPCs, demonstrated with an extended test at the CERN-GIF on two detectors, reproducing the experimental conditions expected for the LHCb experiment. The conclusion from the analysis of the test results show that the RPC detectors could be built to meet the TDR specifications but their performance would quickly degrade. This fact led the collaboration to the decision of replacing RPCs with MWPC detectors.

The Addendum to the Muon System TDR was received on January 15, 2003 (CERN/LHCC 2003-002). On January 27, 2003, the referees discussed questions with the LHCb collaboration. The referees were K. Borras, F. Ferroni and Y. Karyotakis.

2 Detector Technology

The LHCb Muon System consists of 5 muon stations located along the beam axis and covering the angular region of 20 to 306(258) mrad horizontal(vertical). Station 1 is placed immediately after RICH2 while Stations 2 to 5 are behind the hadronic calorimeter and are interspersed with a shielding wall, totalling 20 nuclear interaction lengths. Hits on all 5 stations are required to trigger, corresponding to a minimum muon momentum of 5 GeV/c. Each station is subdivided radially into 4 regions each one having a different granularity to cope with different particle rates. MWPCs are proposed for the entire detector except for Region 1 of Stations 1 and 2.

The proposed detector is made by the same MWPC as discussed in the TDR except for one modification. The anode to cathode distance is 2.5mm while the anode-wire spacing is 2.0 mm, for a 30 μ gold-plated tungsten wire. Each chamber contains 4 sensitive gaps, grouped by 2 to the front-end electronics, providing redundancy and high efficiency. The anode-wire spacing of 2.0 mm (c.f. 1.5 mm quoted in the TDR) has been chosen after a detailed performance comparison that validated the proposed option. This change leads to an easier construction and a cost saving.

The M1 chamber will have only two gaps instead of four. In addition, the panel core will be Nomex honeycomb, in contrast to polyurethane foam foreseen for the panels in the other station. This is done in order to minimize the material in front of the electromagnetic calorimeter and preshower (0.15% instead of 0.33%).

The design relies on a technology already approved at the time of the TDR and does not give rise to any significant concern.

For the inner part of Stations 1 and 2, the technology has not yet been selected. The LHCb collaboration considers presently two different options: one is a triple-GEM solution while the other is a modification to the standard MWPC design. For a decision to be made, further R&D is needed, especially in respect of ageing due to the high particle rates, which are above 100 kHz/cm^2 in the inner regions.

3 Management Structure

The decision to abandon RPCs for MWPCs poses a number of organisation issues to the collaboration as the total surface area of the MWPCs has now doubled. A tentative sharing of responsibilities exists but is neither exhaustive nor exclusive. The details of the organisation chart should be known by the time of the engineering reviews.

4 Comments

The LHCC finds the detector technology proposed for the Muon chambers adequate to achieve the physics goals stated in the Technical Proposal, and **congratulates** the LHCb collaboration for the impressive effort made in a very short time to recover from an unforeseen event.

Although there are no major concerns, the LHCC notes that:

- The collaboration should perform extensive ageing tests, including exposure to high intensity hadron beams, for the two options for Regions 1 and 2 of M1.
- The details of the organisation and responsibilities should be worked out as soon as possible in view of the very tight schedule for the chamber production.

A list of agreed milestones is appended, which comply with the current LHC schedule, and which will be used to monitor and regulate the progress of the project.

Muon System Milestones

Milestone	Date
MWPC	
Engineering design completed	04.2003
Begin chamber production	07.2003
10% chamber production	03.2004
50% chamber production	02.2005
Chamber production and test completed	03.2006
Chambers for the inner part of M1	
Technology choice	06.2003
Chamber construction completed	12.2005
Electronics	
Full chain electronics test completed	06.2003
Integrated Circuits	
CARIOCA review and decision on FE chip	09.2003
DIALOG design and test completed	09.2003
SYNC design and test completed	09.2003
IC Engineering Run (CARIOCA,DIALOG,SYNC)	12.2003
FE Boards	
Begin board production	04.2004
10% board production	08.2004
50% board production	03.2005
Board production and test completed	10.2005
IB,ODE,SB Boards	
Begin board production	04.2004
10% board production	12.2004
50% board production	06.2005
Board production and test completed	12.2005
Muon filter and support structures	
Iron filter installation completed	12.2004
Chamber support structures installed	06.2005
Commissioning	
Muon System commissioning completed	09.2006
Muon System ready for beam	04.2007