CERN/LHCC 2001-028
4 October 2001

Review of the LHCb Vertex Locator System Technical Design Report

1 Introduction

This document describes the process and conclusions of the review of the LHCb Vertex Locator (VELO) system, which is designed to provide precise measurements of track coordinates close to the interaction region.

Decay vertices displaced from the production vertex is a fundamental feature of b-hadron decays and a high-quality vertex detector is required to measure these vertices. The Vertex Locator is used in reconstructing b- and c-hadron decay vertices, separating these decay vertices from the production vertex, accurately measuring decay lengths, and measuring the impact parameters of particles used to tag their flavour. Furthermore, the VELO provides an essential input to the Level-1 trigger.

The VELO TDR was received on 31 May 2001 (CERN/LHCC 2001-011). On 13 June, the referees discussed the document with the collaboration. The open presentation was given to the LHCC session on 2 July. Following the LHCC meeting the LHCb group received a number of questions. The response to these questions and a discussion of milestones took place in the referees' meeting on 1 October. The referees were D. Cassel, Y. Karyotakis, and H. Schellman.

2 Detector Technology

The LHCb Vertex Locator is designed to reconstruct the primary p-p and secondary b-hadron decay vertices with a decay length resolution of 200 to 400 μm over an angular range defined by the spectrometer from 15 mrad to 300(250) mrad in the horizontal(vertical). The VELO must operate in a harsh radiation environment as close as 8 mm to the beam. The detector consists of 25 stations made up of a total of 100 Si sensors. The sensors chosen are 300 μm n-on-n with double metal layers. This choice of technology is justified by an extensive testing programme with prototypes very similar to the final proposed design. Two candidate readout systems are under consideration, the SCTA_VELO version of the SCT128 chip and the Beetle. Prototypes are available and tests are in in progress.

The design of the beam pipe in the VELO region must minimize material and wake fields while retaining good RF shielding and a high quality vacuum. The LHCb collaboration has been working together with the LHC vacuum and accelerator physics groups on a beam-pipe/vacuum system which achieves these goals. The

design chosen is a dual vacuum system which allows access to the Si sensors without exposing the primary LHC vacuum. An important constraint on the design is that – even in the event of a severe failure which requires replacement of the beam pipe – it should not be necessary for the LHC machine to be down for more than two weeks.

3 Comments

The LHCC finds the detector technology adopted for the Vertex Locator adequate to achieve the physics goals stated in the Technical Proposal, and **congratulates** the LHCb collaboration for the quality of work presented in the TDR.

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

- The vacuum and RF shield remains a substantial technical challenge that must be met. The LHCC expects to be kept informed of progress.
- Continuation of the established close collaboration with the LHC machine groups on the implementation of the vacuum and RF shielding systems is essential.
- Any substantial change, such as in the material or thickness of the beam-pipe or in sensor technology or thickness, must be justified in an addendum.
- A more complete confirmation of VELO performance and the linking of tracks with the tracking system should be included in an addendum.
- The choice between the SCTA_VELO and the Beetle readout systems should be justified in an addendum.

The LHCC recommends that LHCb follows the established practice of conducting independent reviews of the engineering designs.

A list of agreed milestones to monitor and regulate the progress of the project is appended.

Vertex Locator Milestones

Silicon Sensors	
Tests of prototypes completed	Jul 2002
design review and start of tendering	
Place final order	Dec 2002
Sensor production finished	Jun 2003
Module production finished	Sep 2004
Test of detector halves in beam	Apr 2005
Front-end chip	
Characterization of chips completed	Dec 2001
Front-end chip decision	Mar 2002
Production/testing completed	Dec 2002
L1 electronics	
Read-out board 3 prototype	Sep 2001
Analog links tested on large scale	Dec 2001
Final prototype of digitizer board	Mar 2002
L1 electronics production starts	Mar 2003
10% of boards completed	Aug 2003
50% of boards completed	Apr 2004
Production/testing completed	Mar 2005
Mechanics/Vacuum	
Production readiness review with LHC groups	Feb 2002
All production drawings finished	Mar 2003
Production/testing completed	Jun 2004
Installation	
Start installation in IP 8	Dec 2004
Commissioning of DAQ with other sub-detectors	Oct 2005
Installation completed	Dec 2005