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PRINCIPAL LHCC DELIBERATIONS

26TH MEETING OF THE LHCb RESOURCES REVIEW BOARD

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13 APRIL 2011

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GENERAL

This document summarizes the principal LHCC deliberations concerning LHCb at the Committee's sessions in November 2010 and March 2011.

The LHCC considers that LHCb has made excellent progress in all aspects of the experiment and the Committee congratulates the LHCb Collaboration on its achievements.

CONCERNS FROM THE PREVIOUS LHCB RESOURCES REVIEW BOARD

SUB-SYSTEM	CONCERN	STATUS
Ring Image Cherenkov (RICH-1)	Low light yield of aerogel radiator following Freon gas contamination.	The detector has been shown to perform with much better resolution when operated in CO_2.
Optical Links (VCSEL)	Failure for several sub-systems.	The experiment is responding effectively by stocking many units for replacement and testing a new version provided by the supplier.

STATUS OF EXPERIMENT

SUB-SYSTEMS

The LHCb detector is working exceptionally well, with over 98% of good channels in any sub-system.

Much work has been done during the 2010-2011 Technical Stop, including the replacement of many Hybrid Photon Detectors (HPDs) with high currents, silicon modules with broken micro-bonds and failed optical links (VCSEL). Three additional VCSELs failed in the few weeks of recent operation with beams. The experiment is responding effectively to this problem by stocking many units for replacement and testing a new version provided by the supplier. The source of the increased high-voltage currents in the Trigger Tracker (TT) has not been identified during the Technical Stop. In spite of taking some preventive measures, the problem has been observed again with beams in 2011 and needs to be kept under control and possibly fixed. The Cherenkov aerogel radiator of the Ring Imaging Cherenkov (RICH-1) detector has been shown to perform with much better resolution when operated in CO_2. A very light carbon fibre enclosure is being made and will be available shortly.

OPERATIONS

Given the running conditions decided at the LHC Performance Workshop at Chamonix in January 2011, LHCb could run with up to μ=2.5 interactions per crossing and an instantaneous luminosity less than 3×10^{32} cm^{-2} s^{-1}. This implies that the experiment would like to run with as many bunches as possible, 700 or more, and that it is important to apply luminosity levelling, which appears to be quite feasible after previous and very recent tests. Expectations are to collect ~200 pb^{-1} by June 2011 and up to 1 fb^{-1} by the end of 2011 if these conditions are met.

LHCb requests to increase the data logging rate from 2 to 3 kHz in 2011 to fully exploit its charm physics potential without compromising the beauty sector. The LHCC endorses this valuable extension to the LHCb physics programme.

PHYSICS ANALYSIS

The LHCC is very impressed with the physics results shown recently by LHCb on various occasions. The experiment is clearly demonstrating its potential to deliver a world-class set of flavour physics measurements. The LHCC also notes that the experiment has also increased its efficiency in releasing physics results.

FUTURE PLANS

The LHCb Collaboration has presented a very detailed Letter of Intent (LoI) describing its upgrade plan. The basic assumptions are that LHCb can integrate about 5 fb^{-1} before the 2017 LHC shutdown. The physics case for the upgrade is based on a planned total integrated luminosity of 50 fb^{-1}. This can be achieved by running luminosity levelled at $L = 10^{33}$ cm^{-2} s^{-1}; with the maximum number of bunches in the machine the expected average number of interactions per crossing is μ=2.3, which has already been demonstrated to be acceptable. The L0 hadronic trigger becomes very inefficient under these conditions, thus cancelling the gain from the increase in luminosity. The main goal of the proposed upgrade is therefore to solve this problem with a major front-end, DAQ and trigger upgrade. This allows the detector to be read out at 40 MHz and the data to be fed to an expanded Higher Level Trigger (HLT) for triggering. A Lower Level Trigger (LLT), in replacement of L0, is left to control the rate into the HLT and to allow staging of the upgrade if needed. Additional detector improvements are also proposed, especially in the area of Tracking and Particle Identification. The proposed data-logging rate of the upgraded detector is 20 kHz.

The LHCC has discussed the LHCb LoI and makes the following comments:

Physics Case:

The Committee congratulates LHCb for the excellent work done on the physics case for the upgrade. It finds the arguments for flavour physics with 50 fb^{-1} very compelling. This amount of data allows measurements at the level of the theoretically achievable precision for many quantities sensitive to new physics. With 5 fb^{-1} of collected data, most searches for deviations from the Standard Model (SM) predictions will be turned into precision measurements of the SM value with the LHCb upgrade. The level of accuracy achievable is comparable, in case of overlap, with that foreseen at future SuperB factories with 50 ab^{-1}; this makes the upgraded LHCb experiment a well-matched competitor and a very important complement.

Physics capabilities in the area of lepton flavour violation, electro-weak and exotic physics are also noted as a welcome addition to the LHCb physics potential. The LHCC encourages the Collaboration to understand this potential at a deeper level.

40 MHz Front-end/DAQ/Trigger Upgrade:

The solution proposed appears to solve the bottleneck due to triggering on the hadronic beauty and charm decays by replacing the L0 calorimeter trigger with a tracking trigger. This is consistent with previous experience that demonstrated that tracking triggers can work quite well to select events with b- and c- hadrons. The solution chosen is also appreciated for its great flexibility and the possibility to implement complex selections.

The LHCC appreciates the introduction of the LLT, which improves significantly the robustness of the upgraded trigger and also allows the possibility to stage the upgrade of some sub-detectors.

The Committee notes that the proposed LHCb upgrade implies a significant additional load on the HLT. The upgrade also has a major impact on the whole detector since a large fraction of the electronics and several detectors need to be replaced. Given this large impact, the Committee requests that LHCb work on developing a deeper insight in the concept of the 40 MHz trigger and of its implications, possibly with an internal review, to confirm its feasibility and to define a baseline plan. Based on the outcome of this review and on the associated documentation the LHCC could issue a recommendation regarding proceeding towards a Technical Design Report in one of its upcoming sessions.

Detector Upgrades:

The LHCC supports the plans to improve the redundancy of the tracking system since it is a natural way to deal with the increased number of interactions per crossing. Replacement of the HPDs in the RICH detectors is also encouraged. In both cases, several R&D activities are currently in progress. The Collaboration should decide soon on a procedure to choose their baseline solution.

20 kHz Data-logging Rate:

This large possible output bandwidth gives much flexibility to the upgrade programme. It also has major implications for the associated computing resources. The LHCC considers that the physics motivation behind this request is not yet clear. The LHCC would like to see a plan of the output streams with their physics motivation and bandwidth. This is not a decision to be taken soon. When the time comes the logging rate will be tuned based on the physics motivations and the available resources.