CERN-RRB-2013-037
11 APRIL 2013

PRINCIPAL LHCC DELIBERATIONS

30TH MEETING OF THE LHCB RESOURCES REVIEW BOARD

17 APRIL 2013

EMMANUEL TSESMELIS

SCIENTIFIC SECRETARY, LHCC

GENERAL

This document summarises the principal LHCC deliberations concerning LHCb at the Committee's sessions in December 2012 and March 2013.

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

No major concerns were reported to the previous LHCb Resources Review Board.

STATUS OF THE EXPERIMENT

PHYSICS

The LHCb Collaboration has published about 100 high-quality physics papers. Many new exciting results have been shown, such as the measurement of new B_c decay modes, the J^{pc} measurement for the $\chi(3872)$, the first search for mixing-induced CP violation in $B_s \to \varphi\varphi$, the observation of the rare charm decay $D \to \pi\mu\mu$ and a search for Higgs-like particles. However, the recent highlight was the status report on the CP violation in the charm system. LHCb updated the pion-tagged analysis using 1 fb^{-1} of fully reprocessed data compared to the previous analysis using 600 pb^{-1} done with fast processing. The significance for ΔA_{cp} was reduced from $>3\sigma$ to 2σ. Furthermore, a new muon-tagged channel was added that yields a positive value for ΔA_{cp}. The new world average only has a significance of 2.2σ and thus does not confirm the evidence for CP violation in the charm system. The reprocessing of the full dataset has been completed. Most of the results for the summer conferences will be based on this new dataset. Another important work in progress is the implementation of different detector geometries for the study of alternative technologies in the LHCb simulation. This was accomplished together with the choice of four physics channels to be used as a baseline for the comparison. A new document on the LHCb upgrade physics and trigger is being prepared that will serve as supporting documentation for the upgrade reviews.

OPERATIONS

The LHCb experiment has completed its 2012-2013 data-taking period with special proton-proton, proton-Pb, and Pb-proton runs. For the proton-proton collisions, the most important special runs were the physics runs at 25 ns (2.56 pb^{-1}) and at high luminosity (5.55 pb^{-1}), which both were acquired with the magnet down polarity. Considering the increase in average multiplicity, the running at 5-6 $\times 10^{32}$ cm^{-2} s^{-1} at 8 TeV is equivalent to running at 4×10^{32} cm^{-2} s^{-1} at 13 TeV so that these tests can shed light on the experiment performance in LHC Run II starting in 2015. The reconstruction of (i) $B \to J/\psi\, K, K_s$ (ii) $J/\psi \to \mu\mu$ and (iii) $D \to K\pi$ has been compared in different running conditions. The background level, resolution and reconstruction yields are essentially unchanged with respect to the standard LHCb running. The only noticeable exception is in events of type (iii), where the yield at 25 ns is better than that for standard running. However, the yield at high luminosity is slightly deteriorated. These changes are related to the current Ring Image Cherenkov (RICH) detector performance with respect to the channel occupancy.

LHCb integrated 1.4 nb^{-1} (0.6 nb^{-1}) of proton-Pb (Pb-proton) collisions and the detector performed well in the very busy high-multiplicity environment. The reconstruction of K_s, Λ and Λbar shows very clean signals emerging over a uniform combinatorial background. In the Pb-proton runs, the

combinatorial background is almost a factor of three larger than that in the proton-Pb runs due to the detector acceptance. By injecting Ne in the SMOG system, LHCb also succeeded to record a short Pb-Ne run, which is equivalent to collisions with a center-of-mass energy of 54 GeV.

LONG SHUTDOWN 1

The LHCC reviewed the Long Shutdown 1 (LS1) activities for LHCb and focused on three high-priority goals: i) how to retain the knowledge acquired so far in running the detector; ii) how to improve the running conditions, and iii) what running conditions can be tolerated at the start-up of Run II. Concerning the first goal, a dedicated workshop will be organised on a regular basis and in the second half of 2013 additional commissioning weeks will be held. In this long shutdown period, experts will carry out continuous improvement on monitoring, triggering and data quality. During Run II, running conditions are assumed to be 25 ns bunch crossing (lower average number of interactions per crossing, μ), a levelled luminosity of 4×10^{32} cm^{-2} s^{-1} and 13 TeV energy (yielding a higher multiplicity and higher b-quark and c-quark production cross-sections). It is clear that the increase in cross-section and multiplicity requires an improvement in data quality, a refinement of the High-Level Trigger (HLT) and a higher CPU usage. Thus, a discussion on a new computing model has started. In the current model, the prompt processing was done on 100% (30% from June 2013) of the collected sample followed by a lengthy procedure of alignment and calibration of the detectors and a dedicated reprocessing. The new proposal is to change the order, i.e. run the calibration (and the Data Quality Monitoring) on a 100 Hz dedicated express stream, store the data waiting for the calibration to be completed and then run the full reconstruction. This avoids the prompt processing i.e. reduces the CPU needs but increases the need for disk and tape.

UPGRADES

The LHCb upgrade is advancing well. After the LHCC endorsement in September 2012 and Research Board approval in November 2012, the LHCb Upgrade Resource Board is addressing resources and funding from the agencies. So far, from informal feedback from funding agencies, the Collaboration expects to count on about 70% of the requested funds. This will be a continuous process that will take at least five to six additional months before completion. A clearer and more official status will be available in April 2013. On the positive side, the manpower of the Collaboration is also increasing with new groups joining from the USA, Netherlands and Italy, thus improving the potential and strength of the Collaboration. In the meanwhile, the document on the upgrade milestones for the Technical Design Report (TDR) of the subsystems has been released to the LHCC. So far, the number of milestones reached is consistent with expectations. In the next months, however, the slope (number of milestones/month) will dramatically increase. Just as an example, at least three other major pre-TDR reviews are expected in the next six months, together with a final decision on the electronics architecture for the sub-systems. The LHCC confirms that the milestone document is a useful tool for referees and the Collaboration for monitoring the progress on the upgrade.

The LHCC has reviewed plans for the Scintillating Fiber (SCiFi) Tracker, the Vertex Locator and the DAQ:

- For the SCiFi upgrade, an external independent review was carried out to determine the viability of this option. The basic question was the radiation hardness of the scintillating

fibres (Kuraray SCSF-78MJ) and of the Silicon Photomultipliers (SiPM). Radiation damage of the scintillating fibres was found to increase logarithmically with dose. Extrapolating the light-yield loss to 50 fb^{-1}, the worst damage is located at the fibre end close to the beam where the light yield is reduced to 28% with respect to light yield observed at the end close to the SiPM. However, by selecting signals within a narrow time window and by adding a mirror on the end close to the beam, the light yield can be almost fully (80%) recovered. For the SiPM, a comparison between Ketek and Hamamatsu demonstrated that the Ketek photosensors have better Photon Detection Efficiency than the Hamamatsu type and that they still can be operational at a dose produced by a luminosity of 50 fb^{-1}. The external review concluded that radiation damage is not a show-stopper for this option and urged the proponents to carry on with the necessary R&D: constructing a Module-0 at full length (2.5 m) and completing the design for the front-end electronics (FEE) and the overall detector. In this respect, the review was positive and LHCb is considering replacing the overall Outer Tracker with a SCiFi tracker.

- Concerning the VELO, LHCb presented a full system report where they showed many details on simulation, cooling options, RF foil, sensor and read-out chains. A critical issue is the proposal of reducing the VELO active area from an inner radius of 7.5 to 5.1 mm. Though the VELO will indeed gain a large factor on interaction point resolution, the closer proximity to the beam may cause some issues due to an increased exposure to wake fields, which LHCb foresees to overcome with a RF-shield milled from a single slab of aluminium. LHCb, however, is confident that their design will work due to their operational experience of the VELO in the past years and due to detailed knowledge of the location of detector obtained by surface tomography via reconstruction of nuclear interactions. The presentation of this proposal occurred at the LHC Machine Committee (LMC) meeting on 12 December 2012 and the feasibility will be further discussed. The work for the VELO is proceeding well. Both options for the sensors expect to have a TDR ready by the third quarter of 2013.

- An independent technical review was also carried out for the DAQ/FEE system. The upgrade architecture is based on the 40 MHz read-out of the FEE. This is accomplished by means of modified FEE boards (with zero suppression) linked to a 40 MHz acquisition board, TELL40, that has a rate control from an external Low Level Trigger and transmits data to the HLT farm. The reviewers found that the obsolescence of the old system should be addressed and reviewed. They advocate the need for buffering on the TELL40 board and to organise the TELL40 firmware. They also suggested using links from the TELL40 to the DAQ. The risks connected with the very tight schedule for the ASICs were also shown. An improved /enlarged collaboration is crucial for this item.

The LHCC **congratulates** the LHCb Collaboration for its success in being compliant with the upgrade milestones and hopes that this continues smoothly also in the very busy schedule expected next year.