Status of the LHCb experiment

CERN-RRB-2011-103

10 October 2011

1 Introduction

The LHCb experiment has collected 1 fb^{-1} of integrated luminosity during the 2011 LHC run at a centre-of-mass energy of 7 TeV. The majority of the data was recorded at an instantaneous luminosity 3.5×10^{32} $cm^{-2}s^{-1}$, nearly a factor of two above the LHCb design value, and with a pile-up rate of ~ 1.5 (four times the nominal value). Thanks to the outstanding performance of the LHCb detector and its operation, the overall data taking efficiency exceeded 90%. Only 1% of this data has to be discarded for physics analyses. The LHCb experiment continues to provide high quality measurements in the forward direction which complement well the physics results from the general-purpose detectors, ATLAS and CMS. The detector is optimised for flavour physics, and the results obtained with this year's data now surpass the Tevatron and B-factories in certain benchmark analyses. No indication of new physics has been observed so far, but there is excellent discovery potential in the ongoing run.

LHCb has not participated in Heavy Ion running at the LHC so far, due to the unacceptably high occupancy that would be produced in the tracking detectors in the forward region covered by the experiment, for Pb-Pb collisions. However, at the end of 2012 it is proposed to take data with proton-Pb collisions, for which the occupancy is expected to be acceptable, and the complementary information from the LHCb coverage would be interesting. A test of proton-Pb collisions is planned at the end of this year's run.

2 Detector subsystems

With a channel efficiency well above 99% for almost all sub detectors, LHCb continued its successful performance. The instantaneous luminosity has been increased constantly and the detector has shown to be able to run with a rate above the nominal design value. The higher current in some of the TT modules have been decreased considerably due to a modification to the inside of the detector walls.

The mortality rate of the VCSELs has stabilized to a very low rate and is no longer a concern. In view of the upcoming technical stop over winter 2011/2012, LHCb has started to schedule required maintenance and consolidation work including all yearly safety tests. Several major consolidation works of the infrastructure have to be planned carefully to allow efficient interventions on all sub-systems.

2.1 Beam Pipe

Manufacturing of the replacement of the biggest beryllium cone of the beam pipe (UX85-3) continues at the contractor site. A welding qualification campaign is in progress following the development of a small crack close to the weld after assembly of the two smallest sections. Re-machining of the welding interface of these sections has been performed and they are ready for final assembly once safe welding parameters are established. An integrated attachment system for the supports (fixed points) in the magnet has led to a modified version of the beryllium collars. Manufacturing drawings have been finalized and procurement of one prototype in aluminium will be done in the next months. Qualification of the mechanical properties of the carbon composite tubes and cables, including terminations and attachments, are scheduled after exposure at an irradiation facility next month. The design of a backup solution with aluminium cables has been prepared. Assembly tests of the complete attachment system with the aluminum prototype collar will follow. Test samples for the spares of the smallest aluminium bellows have been manufactured and tooling for machining the bigger aluminium bellows are in preparation at CERN.

2.2 Vertex Locator (VELO)

All components of the system have performed well throughout the 2011 run. A hit resolution of 4 μm has been achieved at the minimal pitch and optimal track angle, and an alignment accuracy of 1 μm. The detector is only 8 mm from the LHC beam, and hence receives a high radiation dose as the LHC delivers high luminosities. The depletion voltages and current are changing in line with expectation. Radiation damage monitoring has been put in place using current, noise, and dedicated charge-collection efficiency versus voltage scans. The inner parts of the n-in-n sensors have now type-inverted. The connectors on the low voltage system have not proved sufficiently robust, and a change of the back-planes of the low voltage crates is foreseen for the winter technical stop. All modules for the first half of the replacement VELO system have been delivered to CERN, and the mechanics for both halves. The assembly of the first half of the replacement VELO system has started.

2.3 Silicon Tracker (ST)

The operation of the Inner Tracker (IT) and the Tracker Turicensis (TT) has been very smooth and stable over the last months. The operation of the detectors is in the hands of the central shift crew, supported by an on-call piquet. Detailed monitoring of the detector status and performance ensures safe and efficient data taking. Currently, more than 99.7% of channels in the TT and 98.2% of channels in the IT are fully operational. The non-working channels in the IT required opening the detector, hence will be tackled in the long technical stops during winter. To improve the situation with high currents in the TT, a very thin Kapton foil was installed in the inner part of the Faraday cage of the detector. Now, the number of sectors with high currents, as well as the size of the currents, are both considerably reduced. This clear improvement in combination with an adapted luminosity levelling at LHCb allowed to operate the TT at higher peak luminosities ($3.5 \times 10^{32}\mathrm{cm}^{-2}\mathrm{s}^{-1}$). The performance of the detector is very good and the S/N is within the expectations from previous test-beam studies. Various tools are being put in place to monitor the radiation damage of the detector. Preliminary results show radiation effects of the silicon sensors that are fully consistent with the predictions. Lowering the operational temperature of the sensors to ease the operation in the long run is still under discussion.

2.4 Outer Tracker (OT)

The detector and readout electronics operated reliably and the number of dead channels is well below 1% over the operation in 2011. One of the 432 VCSEL transmitters on the on-detector serializer boards died in 2011 (compared to five in 2010). In addition, a trip of the high-voltage occurred in August 2011 which possibly points to a broken wire. Calibration parameters, such as noisy channels, drift time-to-space $t(r)$ relation, time offset and space alignment, have been determined, transferred to the appropriate databases, and found to be stable during detector operation in 2011. The detector operated with 1.5% of molecular oxygen added to the nominal $\mathrm{Ar/CO_2}$ gas mixture, in order to reduce the effect of aging as found in the laboratory; further irradiation in situ during the technical stops in the 2011 running period confirmed the beneficial effects. A large analysis effort has been made to allow for a timely determination of the onset of aging effects, based on the usage of tracking to "map" the stability of the detector. Every 200 pb^{-1} dedicated runs were performed to study the hit efficiency at elevated amplifier threshold values. These procedures have been demonstrated to be sensitive to gain variations of the order of 10%, and are thus a powerful technique for a timely detection of aging effects. So far no reduced gain from aging has been observed, but possible aging remains a concern and will be watched closely. Curing existing gain losses through an HV training procedure has also been demonstrated in situ and a remotely-controlled procedure has been tested during the technical stop of the 2010/2011 winter shutdown.

2.5 RICH system

The RICH system is performing extremely well, in spite of the challenging LHCb running conditions. The CF_4 scintillation issue in RICH2 has been solved by injecting a small quantity of CO_2 into the gas. CO_2 effectively quenches the CF_4 scintillations in a radiation-less mode, leaving unaltered the excellent resolution and photon yield. In May, increased luminosities indicated an anomalous throttling of the UKL1 (DAQ) board, limiting the maximum luminosity to $\sim 3.2 \times 10^{32}\text{cm}^{-2}\text{s}^{-1}$. The issue was solved by applying a new firmware, demonstrating compliance with LHCb rate and event size specifications, with plenty of margin. By significantly reducing background, increasing the number of UKL1s and improving the UKL1 firmware, the physics signal bandwidth is now three times higher than in 2010. Work on the new aerogel box is progressing and the plan is to mount it during the winter technical stop. Operation of the system is made easier by a wealth of automated responses for DCS, DAQ and Safety systems. The HPD replacement campaign is progressing and under control, although the unsatisfactory yield for a few repaired batches slightly reduces the number of available spares. The present worry is Beam-Induced Light Emission (BILE), a phenomenon appearing only with presence of beam and high luminosity. Light is emitted following ionization of the gas by charged particles in the photodetector boxes. By employing an electronegative gas (CO_2) and decreasing the high voltage from 18 kV to 16 kV (without affecting the excellent PID), the possible light emission has been controlled, and shifted into the red/infrared region (invisible to the HPD photocathodes). However, not knowing where the border lies between stable running and BILE onset, the detector is operated with great care and a set of monitoring tools is being put in place.

2.6 Calorimeters (SPD, PS, ECAL and HCAL)

The calorimeters are working very smoothly. A single dead channel in HCAL has been registered and only very few minor hardware interventions were required over this year's running period. Time alignment of the calorimeter detectors has been measured several times over the year. Some changes of up to a few ns in the timing of whole crates have been measured and triggered some L0 synchronization problems. The cause of these shifts is not yet understood but a system to measure relative crate phase has been put in place. The main emphasis has been on the absolute calibration of each calorimeter cell and on its monitoring throughout the year. First signs of detector aging in both calorimeters, ECAL and HCAL, have been observed (no significant change of SPD and PS performances has been measured). The radiation dose degrades the scintillator and optical fibre performance, where mainly the central part of the detectors is affected. So far, the annual dose is moderate and this effect is small. We do not expect degradation of the resolution of the calorimeters. The effect is more visible on the photomultipliers, where the gain decreases with the recorded charge. Different methods have been employed to compensate this effect:

- ECAL: A large sample of π^0 from two separated photons recorded in a short period is used to calibrate each cell of the ECAL. In order to have high statistics to follow short term effects, the ECAL is divided into 8 zones. Electrons from conversion are selected, one leg being used as a tag and the other as a probe. Then the stability of the ECAL is obtained by following the ratio of the deposited energy of the electron in the calorimeter to its momentum measured by the tracking system (E/p) in periods of $\sim$ 40 pb^{-1}. Initial performances of the electromagnetic calorimeter and its expected resolution are recovered for π^0 and B decays including photons.

- HCAL: At each technical stop, corresponding roughly to 200 pb^{-1} of recorded data, calibration runs with a radioactive source are performed and the photomultiplier high voltages are adjusted accordingly to restore their initial gain.

2.7 Muon System

The performance of the Muon System under the high luminosity conditions has been excellent. No particular problems from the point of view of the high voltage system have been observed. Some problems related to the increased input rate to the DAQ boards (the so-called TELL1 boards) have been readily fixed. The amount of tripping HV channels is reduced. During the technical stops in July and August a handful of faulty readout channels were fixed, and currently the dead readout channels amount to only 0.12%.

2.8 Online System

The report period has been characterised mainly by operating the system and applying developments to improve the overall efficiency of the data taking. To this effect many operational procedures have been automated to relieve the shift crew and react fast to events. The HLT farm has been increased by another 120 nodes, thanks to special funds from Switzerland. This additional capacity was very welcome to cope with the rate and complexity of events. The HLT farm is $\sim$ 90% busy at the current running conditions. The state of the controls PCs is being carefully monitored, and a major overhaul (consolidation) of the controls infrastructure is being prepared for the 2013/14 shutdown. In general, the Online system runs at an efficiency in excess of 95%.

2.9 Concerns and plans of the detector subsystems

Concerns:

- The delivery of the replacement of the beam pipe section UX85/3 has been significantly delayed and the welding qualification process has not yet been completed.
- Although the situation with high currents in TT has considerably improved, decreasing the cooling temperature might deteriorate the situation.
- Beam-Induced Light Emission effects in the RICH with higher instantaneous luminosity.
- Long list of tasks for the technical stop during winter 2011/2012, including major consolidation of the infrastructure.

Plans:

- Start preparation for short data taking period with Pb-proton run, if provided by LHC.
- Develop further additional tools for close monitoring of radiation effects on the detector.
- Continue further investigation of the higher current in the TT modules to reduce their appearance further.
- Major consolidation of infrastructure; electrical network, lifting devices, cooling and ventilation controls.

3 LHCb operation

The possibility of running LHCb with an instantaneous luminosity lower than that delivered in parallel to ATLAS and CMS is linked to the use of a luminosity levelling procedure, where the beams are displaced at the LHCb interaction region allowing for a fully automatized fine tuning of the luminosity in the detector. This procedure has permitted reliable operation of the experiment and a stable trigger configuration throughout the year (see Fig. 1).

Except for the month of April during which the LHC was ramping up, the data taking conditions were very stable at LHCb. Most of the data has been taken with between 1000 and 1300 bunches (constantly 1296 from July) and a target luminosity of 3.5×10^{32} cm^{2}s^{-1}. The average number of inelastic pp interactions slightly larger than one, substantially lower than the values up to 2.5 seen in 2010.

During data taking, the magnet polarity has been flipped at a frequency of about one cycle per month in order to collect equal sized data samples of both polarities for periods of stable running conditions.

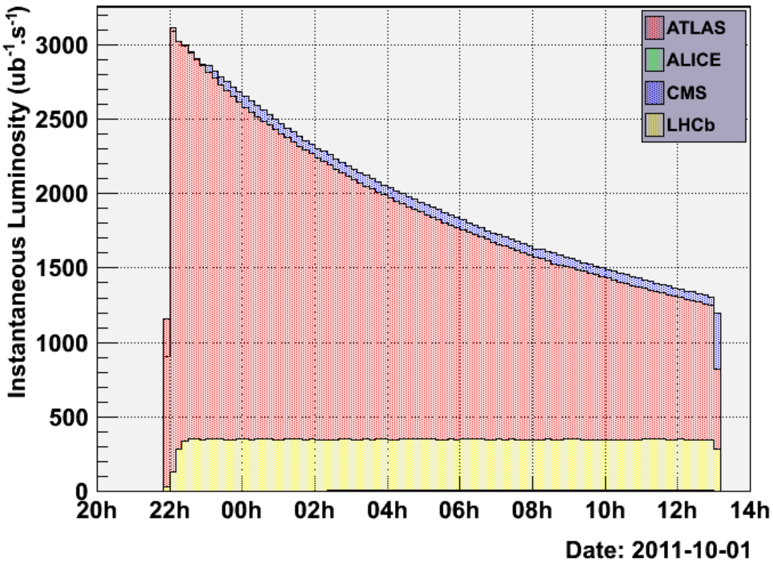

Figure 1: Luminosities of the LHC experiments in a typical fill.

3.1 Trigger

The LHCb trigger is fully functional and the event filter farm (EFF) is completely available and commissioned. The trigger settings have been remarkably uniform compared to last year, thanks to the stable running conditions.

The Level-0 (L0) trigger has been run with stable thresholds throughout the year. Thanks to the lower number of *pp* interactions per bunch crossing and the larger amount of CPU available in the HLT farm, the global event cuts have been relaxed as compared to 2010.

The nominal L0 output rate of 1 MHz has nearly been reached ($\sim$ 800 kHz), but not completely, due to various sources of dead-time. The luminosity was constantly adapted in order to maximise the collected integrated luminosity while keeping dead-time at an acceptable level of a few percent.

The sources of dead-time have been various limitations related to subdetector systems described above, that have been solved during the year. The main residual limitation is from the emulation of the BEETLE front-end chip pipeline, which will be addressed during the winter technical stop.

The high level trigger (HLT) is fully commissioned and is using the data of all subdetectors. A major redesign has been successfully performed during the winter in order to consolidate the framework and better incorporate the improvements made necessary by the larger than anticipated event sizes.

The current output rate of the HLT (3 kHz) is represented by very clean samples of b decays to leptons, b decays to hadrons, and charm decays (each roughly 1 kHz). The total exceeds our design value of 2 kHz. Any further reduction would require downscaling some high rate channels at the cost of physics.

This large rate poses stringent constraints on the stripping, which aims at reducing the total size of the data by a factor 10 before distribution on several Tier1 sites for analysis. This is done combining about 600 physics preselections organised in 10 streams covering all of the LHCb physics programme. The retention rate of the stripping is now in accordance with the target, 39 MB per second of data taking. This has been achieved by reducing the output rate using offline-style selections for many channels, as well as by reducing the size of the events written out for some large rate selections. The so-called micro-DST was commissioned in 2010 for some selected channels and is now used for many analyses.

3.2 Data processing (offline computing)

A detailed report of the LHCb computing usage has been published in Ref. [1], summarized here.

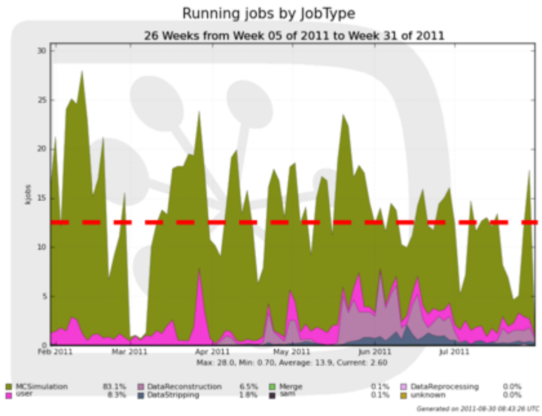

Figure 2: Total number of jobs running versus time. The dashed line shows the pledged value.

The performance of LHCb computing during 2011 has been successful. The LHC has provided data at a rate very close to the expectations with a 30-fold increase over the 2010 data sample. This data has been promptly processed and analysed providing a large number of physics results that have been presented at the summer conferences. The overall level of CPU resource usage has been very close to the expectation (as shown in Fig. 2).

In order to obtain extra CPU capacity for the full reprocessing at the end of the data-taking period, measures have been taken to allow using part of the Tier2 capacity for this purpose, by connecting a number of selected Tier2s to nearby Tier1 storage holding the data. This approach has been tested and is available to provide extra computing power already for the reprocessing of the 2011 data.

At the same time, the CERN share to the CPU resources has been greatly reduced, to around 25% of the sum of resources contributed by all Tier1s. This solves one of the main issues reported in previous reviews.

In terms of storage usage, there have been important changes in the model. The number of replicas has been reduced, the space token definitions have been simplified at the sites providing extra flexibility in the usage of the space, and there have been important clean-up and consistency-check campaigns. There are plans to further reduce the number "fixed" replicas for the different data samples by putting in place a more dynamic mechanism based on the popularity of the data, but this is still work in progress. Despite these efforts, our disk shortfall is 2 PB, as anticipated in the March RRB report. This is only partially mitigated by advances totaling about 0.6 PB out of 2012 pledges from a small number of Tier1s.

The main target for the next months is to make sure that there is enough space available for the all the data to be taken, in particular for the full reprocessing at the end of the year.

3.3 Concerns and plans for LHCb operation

Concerns:

- High trigger output rate needed to accommodate our physics programme setting stringent constraints on our computing. Limitations to L0 output rate.
- The amount of disk space is critically low for 2011 and 2012. Attempt to mitigate this by delaying processing and reducing copies.

Plans:

- Further commissioning to completely fill the 1 MHz readout. Improvements in trigger algorithms.
- Reprocessing of the whole 2011 data sample this autumn.

4 Detector performance

Some of the key features of the LHCb detector are the ability in vertexing, tracking and particle identification: kaons, muons, electrons and photons. In 2011 the effort in optimizing the performance of the detector has continued.

As far as tracking and vertexing are concerned, a new tuning of primary and secondary vertex reconstruction has been implemented, in particular to resolve events where the B mesons decay to a high number of secondaries. Refinements to the tracking algorithms have allowed to speed up the execution and to reduce the number of ghosts. Global event cuts on the total number of OT hits has been increased from 10k to 15k to ensure a better efficiency in processing high multiplicity events. This has not introduced pathological effects in CPU consumption.

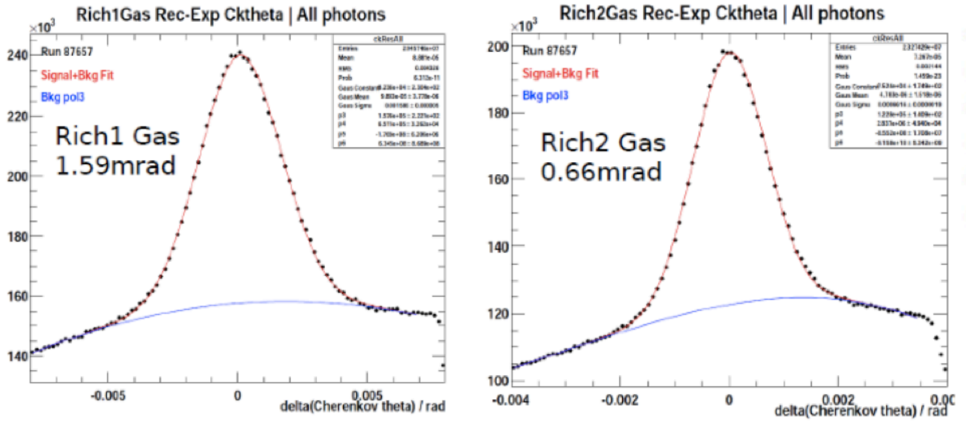

Figure 3: Angular resolution of the two RICH detectors.

Tracking efficiency is high ($> 90\%$) over a wide range of rapidity and track multiplicities, and the systematic uncertainty is now evaluated to be 1% per track (was 2% in 2010), evaluated in data from a large sample of tag-and-probe $J/\psi \to \mu\mu$ events.

The VELO is aligned to 1 μm and the overall momentum resolution shows a trend close to that expected from Monte Carlo simulation. The performance of the VELO leads to a proper-time resolution (as observed in the $B_s \to J/\psi\,\phi$ analysis) of ~ 50 fs. IT and TT still suffer from a moderate z-scale effect, which has been substantially reduced by the introduction of a new partial measurement of the magnetic field, performed during the shutdown. OT is now in its nominal survey position. The new field map has allowed to bring the J/ψ mass-scale uncertainty to 0.1% (was 0.2% in 2010).

Efforts have been made to optimize the response of the RICH detectors. In 2011 the angular resolution has reached that of the nominal Monte Carlo, respectively of 1.59 mrad for RICH1 and 0.66 mrad for RICH2 (see Fig. 3). The aerogel is still far from the expected performance, due to RICH1 gas contamination. Sub-calibration of the refractive index of sections of individual tiles is underway, although not expected to gain a large factor, and the eventual solution will be provided by the separate gas volume for the aerogel that is in preparation.

Calorimeters have shown the first signs of aging, mainly due to variation of the photomultiplier gain. Of particular importance have been the activities for a detailed calibration of ECAL modules affected by a decrease of the π^0 mass peak position. The studies have shown that the mass resolution has remained unchanged at $\sim 6\%$, showing that we are not observing a degradation in photostatistics. New calibrated data have shown a mass resolution in the $B^0 \to K^*\gamma$ decay ~ 100 MeV/c^2, as expected from Monte Carlo (see Fig. 4).

Muon identification maintained its high efficiency in 2011 ($\sim 97\%$) although some effects of dead-time appeared, due to high rate especially in regions (M5R4) hit by back-splash events from beam interaction in nearby LHC magnets. There

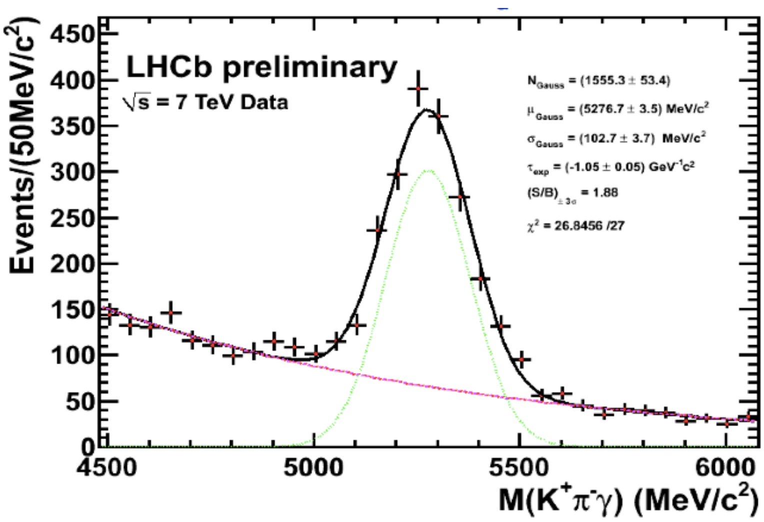

Figure 4: Signal for the $B^0 \to K^*\gamma$ decay.

are plans to reduce these effects both with a better shielding and with a reduction of the width of the digital signal coming from the front-end electronics. Due to increased occupancy, the mis-identification of hadrons has slightly increased. Measures to recover the 2010 situation are under evaluation.

Finally, several analyses have started to use tools for flavour tagging, which have been calibrated making use of large samples of data. Depending on the final states, the Opposite Side taggers show a tagging power $\epsilon D^2 \sim 2$–3%. A detailed evaluation of the performance of the Same Side taggers is ongoing, and will be available for the completion of analyses with 2011 data.

5 Physics results

LHCb contributed almost 30 new results to the 2011 summer conferences, most of which were based on ~ 300 pb^{-1} of data from the 2011 run, which corresponds to approximately a third of the anticipated total sample for the year. In most of these analyses results have been obtained which match or surpass in sensitivity the measurements performed by previous experiments, at the B-factories and Tevatron.

LHCb already published a search for the rare decays $B^0_{s,d} \to \mu^+\mu^-$ using 2010 data [2]. The branching ratio of these modes is very sensitive to new physics, particularly in models such as high $\tan\beta$ Supersymmetry. An update was presented this summer which was of the utmost interest given the recent CDF announcement of a small excess [3] for the B^0_s decay. The new LHCb result has the highest sensitivity yet achieved in this analysis [4], but did not find evidence of any non-Standard Model enhancement. A preliminary limit was set on the branching ratio of $< 1.5 \times 10^{-8}$, at the 95% confidence level. A fruitful collaboration was established with the CMS experiment, which has also searched for this decay [5], and a LHCb-CMS combination performed [6], yielding a result of $< 1.1 \times 10^{-8}$ (95%

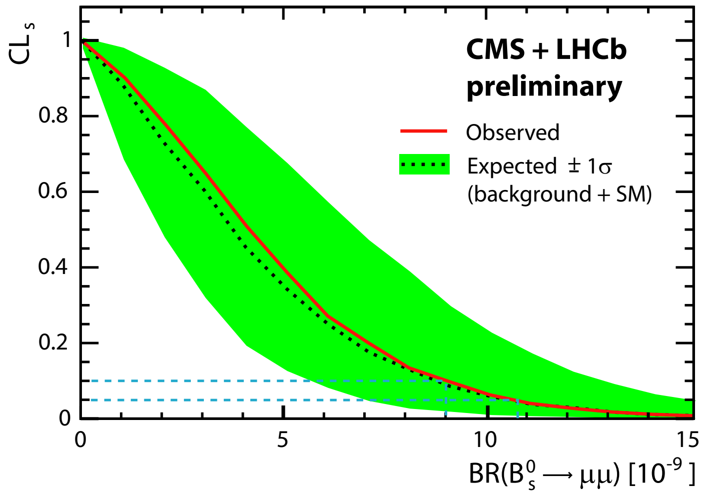

Figure 5: Confidence limit curve versus branching ratio for the $B_s^0 \to \mu\mu$ rare decay, from the combination of LHCb and CMS results.

C.L.), which is a factor of about 3.5 above the Standard Model predicted value (see Fig. 5). Significant improvements in sensitivity will be achieved with the analysis of the full 2011 dataset.

Also of great interest is the search for CP-violation in B_s^0 mixing, which can be enhanced above the very small value predicted in the Standard Model by new physics contributions. LHCb has presented a determination of this phase, ϕ_s, as measured in the decay $B_s^0 \to J/\psi\,\phi$ [7] which already significantly improves in precision on the results obtained at the Tevatron. These results are shown in Fig. 6, which plots ϕ_s against the width splitting $\Delta\Gamma_s$. It can be seen that the LHCb preliminary result agrees well with the Standard Model expectation. LHCb has augmented this study with a preliminary measurement of the same phase in the CP-eigenstate mode $B_s^0 \to J/\psi f_0(980)$ [8]. The combination of the two analyses yields $\phi_s = 0.03 \pm 0.16\,(\text{stat}) \pm 0.07\,(\text{syst})$ [9], again in agreement with the Standard Model. The improved precision that will be obtained on this fundamental parameter with the full 2011-12 dataset will provide high sensitivity to possible new physics effects.

LHCb has also demonstrated its capabilities in the B^0 and $B^\pm$ sector, repeating analyses first pioneered at the B-factories, but with higher statistical precision. Studies have included measurements related to the unitarity triangle angle γ [11, 12, 13] and those concerning flavour-changing neutral current decays. An example of the latter is the mode $B^0 \to K^{*0}\mu^+\mu^-$ which offers a rich spectrum of observables which are sensitive to the helicity structure of any new physics contributions. LHCb has accumulated the world's largest sample of such decays, with excellent purity, and has made a measurement of the forward-backward asymmetry of the dimuon system as a function of its invariant mass [14]. The signal peak and forward-backward asymmetry are shown in Fig. 7. The asymmetry shows the

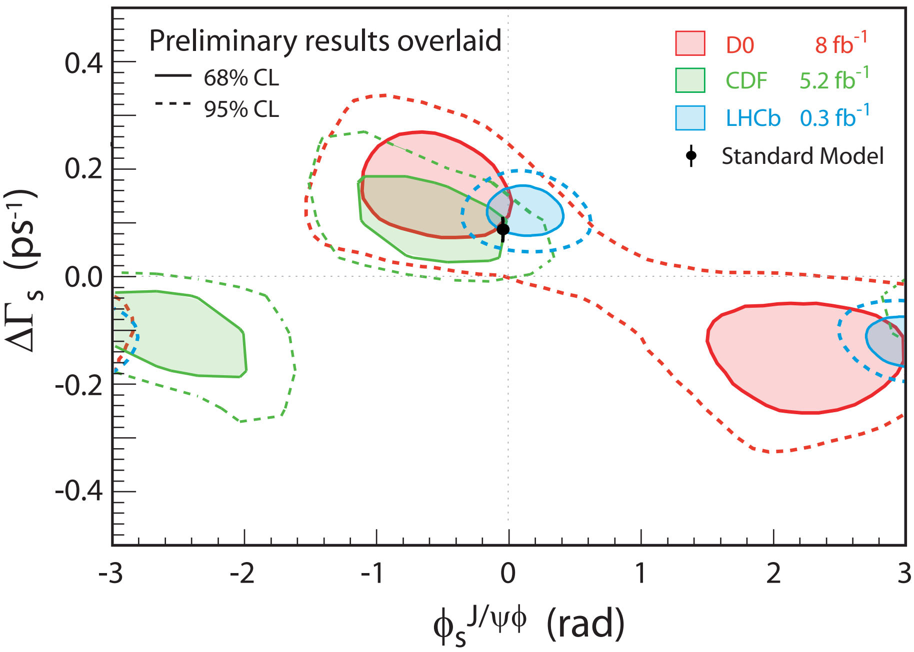

Figure 6: The ϕ_s-$\Delta\Gamma_s$ contours as measured with $B_s^0 \to J/\psi\,\phi$ decays at LHCb with early 2011 data [7] and at the Tevatron [10]. Note that the measurement has an intrinsic two-fold ambiguity. The Standard Model expectation is also indicated.

behaviour expected in the Standard Model within the current precision. With more data it will be possible to determine the theoretically clean "zero crossing-point" of the asymmetry, and to perform a full angular analysis which will allow access to other interesting observables.

Already in 2010 LHCb accumulated samples in low-multiplicity charm decays, such as $D^{*+} \to D^0(K^+K^-)\pi^+$, that are of similar size to those of the B-factories. These have been exploited in measurements of the mixing and CP-violation parameters $y_{\rm CP}$ and A_Γ [15, 16]. In these studies it has been demonstrated that excellent systematic control can be achieved, despite the challenges of the hadronic environment. Analysis of the much larger 2011 dataset is underway, and a corresponding increase in sensitivity is anticipated.

Other recent highlights of the LHCb heavy quark physics results include studies of two-body charmless decays [17], in particular the world's most precise determination of direct CP violation in the mode $B^0 \to K^+\pi^-$, a measurement of the relative branching ratio of the important radiative penguin decay $B_s^0 \to \phi\gamma$ [18] and observations of new decay modes of the B_c^+ meson [19].

LHCb has also performed many studies beyond flavour physics, many of which have exploited the experiment's unique forward coverage and very low $p_{\rm T}$ acceptance. An example of the former is the measurement of heavy boson production [20], including the asymmetry between W^+ and W^- production as a function of the muon pseudorapidity in leptonic W decays, which is shown in Fig. 8.

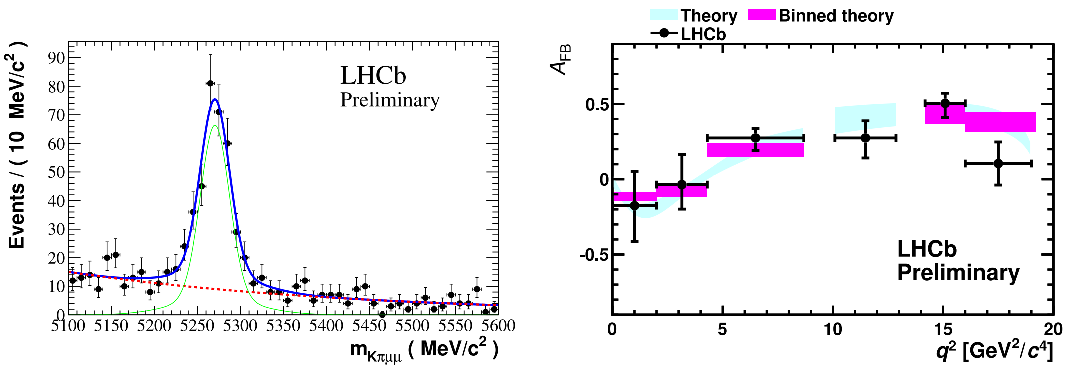

Figure 7: LHCb preliminary $B^0 \to K^{*0}\mu^+\mu^-$ analysis with 300 pb^{-1}. Left: mass peak. Right: forward-backward asymmetry plotted against q^2 of the dimuon pair.

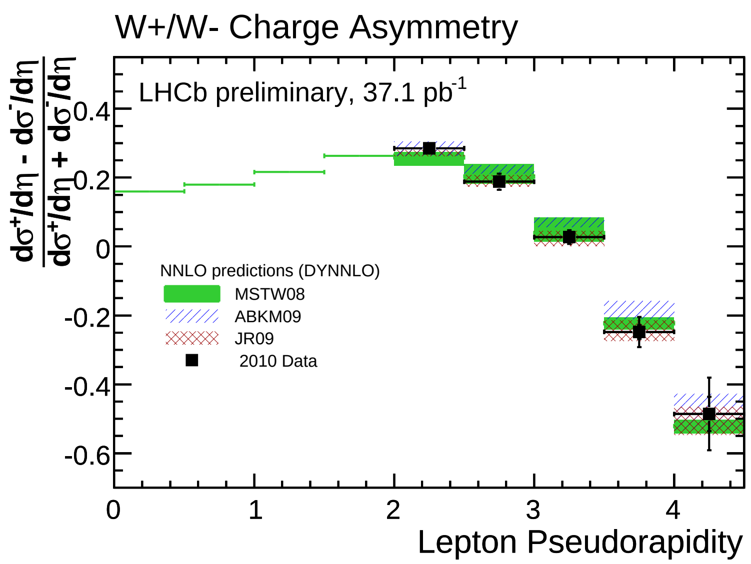

Figure 8: W^+/W^- asymmetry as a function of lepton pseudorapidity compared to the NNLO prediction. The shaded and hatched areas represent the uncertainty arising from the PDF sets tested. The line represents the central value of the prediction for pseudorapidities below 2.

The collaboration is currently preparing the most significant of the summer conference results for journal submission. In parallel the data are being reprocessed with the best available alignment and calibration, to provide a homogeneous $\sim 1\ \text{fb}^{-1}$ dataset which will be analysed for the 2012 spring conferences.

6 LHCb Upgrade

The collaboration submitted a Letter of Intent (LOI) to the LHCC in March 2011, which discussed the compelling physics case for upgrading the detector to run at a luminosity above $10^{33}\ \text{cm}^{-2}\text{s}^{-1}$ with a read-out rate increased to 40 MHz. The physics case was endorsed by the LHCC in its March session and an external review for the 40 MHz readout concept, requested by the LHCC, has been conducted in spring. The LHCC referees found the result of the review very supportive of the upgrade strategy chosen and encouraged the collaboration to proceed in with the preparation of Technical Design Reports (TDRs) for the upgrade.

Consequently, the collaboration has set up an Upgrade Steering Panel which coordinates the upgrade activities between the subsystem projects and R&D in view of preparing the TDRs and the updated Memorandum of Understanding (MoU). Moreover the panel steers the upgrade activities towards the choice of technologies and the sharing of responsibilities. This includes also the monitoring of upgrade project reviews and milestones, together with cost, manpower and funding issues.

The domains covered by the Upgrade Steering Panel are:

- Tracker and tracking: all tracking detectors (VELO, TT, IT, OT), focusing on both the technical issues and the tracking performance.
- Particle identification: both hadronic and leptonic, involving the upgrade of RICH (and TORCH, a proposed time-of-flight detector), the Calorimeter and Muon systems.
- Data processing: the full chain, from detector readout to offline, including the upgrade of Front-End, TELL40, Low- and High-Level Triggers (LLT & HLT), data acquisition and computing.

Workshops for the above mentioned domains are being organized this autumn. Encouraging progress is being made in the various areas of detector and electronics R&D.

7 Financial issues

The status of the accounts is healthy and there is no cash flow problem foreseen.

For 2010 M&O Cat. A budget, the expenditures have generally respected our forecast and for 2011 we do not expect surprises. As in the previous year, 2011 is also a full operations year, therefore we expect a decrease in "Detector related expenditures" and "General Services". In view of the long shutdown in 2013–14 and of the foreseeable important interventions on sub-detectors, on general safety and infrastructure, LHCb is assessing in detail the expected M&O expenditures within a coherent framework.

No institute has indicated that it has additional requests for funds to be presented to the RRB.

8 Collaboration matters

Tim Gershon (Warwick) has been appointed as the Physics Coordinator for one year. His term will start on 1 January 2012.

Massimiliano Ferro Luzzi (CERN), Stephanie Hansmann-Menzemer (Heidelberg), Renaud Le Gac (Marseille) and Guy Wilkinson (Oxford) have been appointed to the LHCb Upgrade Steering Group.

A group from the University of Rostock, lead by Prof. Roland Waldi, has been accepted as associate member. Heidelberg University will act as host institute. The physics interests align well with the LHCb core physics program. Service work agreed upon between LHCb and the Rostock group is in the software sector, including upgrade activities.

A group from the University of Cincinnati has expressed interest in joining the experiment, and negotiations with the LHCb management to define service tasks and contributions to the experiment are well advanced. The group has shown interest in the field of charm physics and of simulations for tracking upgrade. These contacts will generate a funding request to be submitted to NSF by the end of October 2011.

References

[1] "LHCb Computing Resources usage in 2011 (I)", R. Graciani, editor, LHCb-PUB-2011-015.

[2] R. Aaij *et al.* (LHCb Collaboration), Phys. Lett. B **699** (2011) 330.

[3] CDF Collaboration, arXiv:1107.2304 [hep-ex], accepted by Phys. Rev. Lett.

[4] LHCb Collaboration, LHCb-CONF-2011-037.

[5] CMS Collaboration, arXiv:1107.5834 [hep-ex], submitted to Phys. Rev. Lett.

[6] CMS and LHCb Collaborations, CMS-PAS-BPH-11-019, LHCb-CONF-2011-047.

[7] LHCb Collaboration, LHCb-CONF-2011-049.

[8] LHCb Collaboration, LHCb-CONF-2011-051.

[9] LHCb Collaboration, LHCb-CONF-2011-056.

[10] CDF Collaboration, CDF public note 10206; D0 Collaboration, presentation at EPS 2011 HEP Conference, Grenoble, July 2011.

[11] LHCb Collaboration, LHCb-CONF-2011-031.

[12] LHCb Collaboration, LHCb-CONF-2011-044.

[13] LHCb Collaboration, LHCb-CONF-2011-057.

[14] LHCb Collaboration, LHCb-CONF-2011-038.

[15] LHCb Collaboration, LHCb-CONF-2011-054.

[16] LHCb Collaboration, LHCb-CONF-2011-046.

[17] LHCb Collaboration, LHCb-CONF-2011-042.

[18] LHCb Collaboration, LHCb-CONF-2011-055.

[19] LHCb Collaboration, LHCb-CONF-2011-040.

[20] LHCb Collaboration, LHCb-CONF-2011-039.