PROCEEDINGS OF SCIENCE

Flavor physics techniques and sensitivities at LHCb

Olivier Deschamps*, **on behalf the LHCb collaboration**
Laboratoire de Physique Corpusculaire de Clermont-Ferrand, CNRS/IN2P3/UBP
E-mail: odescham@in2p3.fr

LHCb is a dedicated experiment aimed at searching for New Physics in the decays of heavy flavors at the LHC. After introducing the detector and trigger, a brief overview of the final state reconstruction is presented. We also discuss the expected physics performance for few key B decay channels.

Flavor Physics and CP Violation 2009,
May 27 - June 1, 2009,
Lake Placid, NY, USA

*Speaker.

PoS(FPCP2009)021

1. Introduction

Within the Standard Model (SM), quark flavor dynamics is described by the Kobayashi-Maskawa (KM) mechanism which is nicely supported by current B, D and Kaon meson data. The KM mechanism is now well established as the dominant source of CP violation in the Kaon and B meson sectors.

Much impressive experimental progress has been made in flavor physics over the past decade and a quite precise determination of the parameters of the Cabibbo-Kobayashi-Maskawa (CKM) matrix have been achieved from the existing data[2]. Particularly interesting are the parameters, $\bar{\rho}$ and $\bar{\eta}$, which define the apex of the $b-d$ Unitarity triangle. The non-zero value of the latter is the sole source of CP violation in the quark sector. The value of $\bar{\eta}$ is mostly constrained experimentally by the measurements of $sin(2\beta)$ and V_{ub}, leading to a relative uncertainty of about 5% in its value. The parameter, $\bar{\rho}$ is dominated by the measurements of the oscillation frequencies Δm_d and Δm_s, the CKM angle α, and ε_K, but its value is only known to an accuracy of about 20%. Clearly, the CKM metrology has not entered into the high precision era and still there is room for a sizeable contribution from New Physics from flavour changing processes as illustrated in Fig. 1.

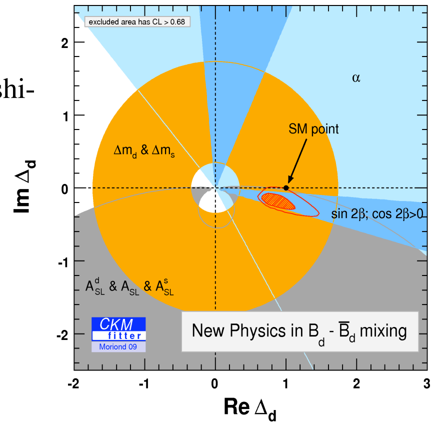

Figure 1: Constraints in the complex plane on the model-independent parameter Δ_d accounting for New Physics in the B_d meson mixing.

LHCb is a dedicated heavy flavor physics experiment. Its main goal is to perform high precision measurements in the beauty sector to over constrain the KM scheme and track down the indirect manifestion of New Physics (NP).

2. The LHCb detector

The LHCb detector [1], illustrated in Fig. 2, is a single arm forward spectrometer. It covers an acceptance corresponding to the large pseudo-rapidity region, from 1.9 to 4.9, where pairs of b quarks are mostly produced in pp collisions. It consists of a precise Vertex Locator (Velo) which is complemented by tracking systems before (TT) and after (T) the Magnet to reconstruct charged particles, two Cherenkov detectors (RICH), which provide an efficient particle identification, the Calorimeter system and the Muon chambers. The main challenge of LHCb is to perform precision measurements in a difficult hadronic environment : the average charged particle multiplicity in the LHCb acceptance is 30, and the background from inelastic processes is approximately 200 times larger than bottom production cross-section. Moreover, LHCb is interested in observing rare or very rare B decays that have branching fractions in the range from 10^{-6} to 10^{-9}, which requires excellent suppression of backgrounds. On the other hand, the rate of b production in LHC collisions is huge and all B species are produced yielding large samples of B_s mesons, as well as B_c and b-Baryons, which are poorly studied so far.

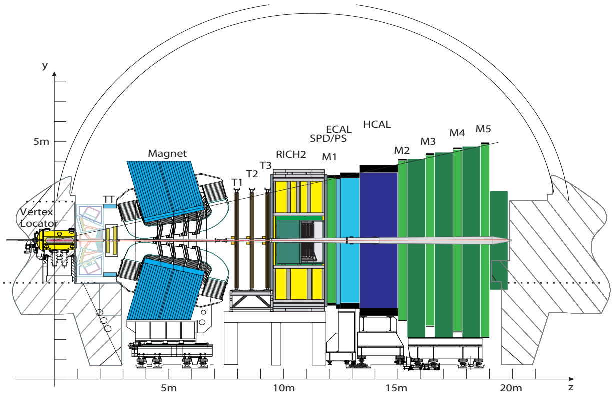

Figure 2: Transversal view of he LHCb detector.

The LHC machine is designed to operate at 14 TeV with a bunch crossing rate of 40 MHz. Due to gaps in the bunch structure, the actual rate for the non-empty bunch crossings is 30 MHz. At the LHCb crossing region, the beam focusing is optimized to obtain a luminosity at the level of a few times $10^{32}cm^{-2}s^{-1}$ in order to maximise single pp-interactions bunch crossings. The expected nominal integrated luminosity per year is 2 fb^{-1}. During the start-up stage in late 2009, the LHC will operate in a different conditions; lower energies of 7 to 10 TeV and much smaller number of bunches. A few hundred pb^{-1} of data are expected to be collected. Within the first day(s), LHCb should collect 10^8 minibias events with simple trigger criteria. To move toward the B meson study, a specific B-trigger is to be setup as discussed in the next section.

3. LHCb trigger strategy

The LHCb triggering is performed in two steps. The first trigger level (L0) is fully hardware and aims at reducing the data rate to 1 MHz.

The L0 trigger exploits the higher transverse momentum of particles from B decay to provide about a factor of 10 reduction in the minimum bias rate with only about a 50% loss in efficiency. The L0 is based on the the fast response of the calorimeters and the muon detectors to identify high transverse momentum hadrons, electrons, photons, neutral pions and muons that could signal the presence of a B decay. The typical thresholds on transverse momentum is 1 GeV/c for muons and 3-4 GeV/c for the deposition in the hadronic and electromagnetic calorimeters. The typical bandwidth sharing is 7:2:1 for hadronic, electromagnetic and muon trigger lines, respectively, leading to a 90% efficiency for B decay channels containing muons, 70% for those containing electrons or photons and 50% for decays with hadronic final states, which can be reconstructed offline.

decay channel	Level-0	HLT1	HLT2
Muonic	90%	~ 80 %	> 90 %
Electromagnetic	70%		
Hadronic	50%		

Table 1: Efficiency of the successive levels of the LHCb trigger on selected events for decay channels containing muons, electrons or photons, and hadronic final states, respectively.

The second level (High Level Trigger) is purely software. In the first step (HLT1), the high transverse momentum objects found in L0 are confirmed using additional information from the tracking and the Velo systems, and additional impact parameter can be applied. The 1 MHz input rate into HLT1 is reduced to about 40 kHz, which is then processed by a second software level, HLT2. HLT2 performs a global event reconstruction using the full information from the LHCb detector. The performance of the L0 and HLT trigger levels are summarized in the Table 1 for decay channels containing muons, electrons or photons, and hadronic final states, respectively.

After these two levels of triggering, the events are written to permanent storage at a rate of 2kHz with an average event size of 35 kB.

4. Resolving the event topology

4.1 Reconstructing the final state kinematics

The LHCb tracking system is 95 % efficient for reconstructing a charged particle with a momentum above 10 GeV/c and achieves a momentum resolution of about 0.5%.
The typical mass resolution for B decay into a charged particles final state is around 15 MeV/c^2 as illustrated in Fig. 3 for the $B_s \to D_s(KK\pi)K$ decay. The good mass resolution allows for an efficient suppression of the remaining background from $B_s \to D_s\pi$ decay with the bachelor pion misidenitfied as a kaon.

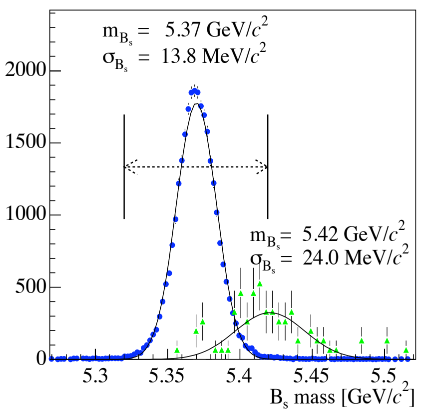

Figure 3: Reconstructed mass for the $B_s \to D_s(KK\pi)K$ decay. The shifted distribution from remaining $B_s \to D_s\pi$ background is shown.

A large sample of long-living strange particle will be produced at LHCb. With the first data taking run, a clear signal from $K_s \to \pi\pi$ and $\Lambda \to p\pi$ is expected. Applying simple kinematical and vertex cuts only, a sample with a purity of 95% can be selected and will be used to obtained cleanly identified protons and pions for the calibration of the RICH particle identification. K_s and Λ also appears in the final state of several decays of interest for LHCb physics program, such as $B \to J/\Psi K_s$, $D \to K_s\pi\pi$ and Λ_b decays. The reconstruction efficiency for these long-lived particle decaying in the LHCb acceptance is 60% with 2/3 of them decayed beyond the vertex detector.
The reconstruction efficiency for photons that are in calorimeter acceptance with a transverse momentum above 200 MeV/c is around 70%. Radiative B decays such as $B_s \to \Phi\gamma$ and $B_d \to K^{*0}\gamma$ can be reconstructed with a mass resolution of 90 MeV/c^2, mostly dominated by the electromagnetic calorimeter (Ecal) energy resolution.
Low energy π^0's can be reconstructed as a pair of well separated photons with a mass resolution of 10 MeV/c^2. For π^0's with transverse energy above 2 GeV, the distance between the two photons becomes of the order of the Ecal granularity, and the photons are likely to be merged into a single Ecal cluster. A dedicated reconstruction procedure has been developed to reconstruct the overlapping photons pair from the cluster's transverse shape. A mass resolution of about 20 MeV/c^2 is achieved

for this high energy π^0 which is important for reconstruction of such decays as $B \to \pi^+\pi^-\pi^0$ decay. The overall reconstruction efficiency is 50% up to a transverse energy close to 10 GeV for neutral pions that decay in the LHCb acceptance.

4.2 The particle identification

Efficient hadron identification over a wide range of momentum is achieved using two RICH detectors with three different radiator materials.

The pair of RICH's provide efficient $\pi - K$ separation up to a momentum of 100 GeV/c, with a Kaon identification efficiency of 97% for a misidentification probability of 6%. The impact of the RICH identification on $B \to h^+h^-$ decay separation is shown Figure 4.

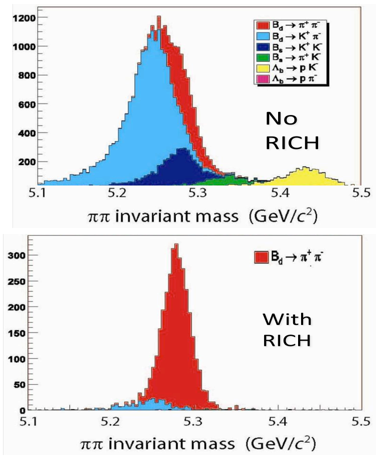

Figure 4: Reconstructed mass for the $B_s \to \pi^+\pi^-$ decays without RICH identification (top) and using RICH identification (bottom) .

The lepton identification is accomplished by the use of the calorimeter and muon systems. Efficient electron identification is provided by the calorimeters information based on the matching of tracks reconstructed by the tracking system and Ecal clusters, the energy deposit in the first electromagnetic sampling layer (Preshower) and the reconstruction of the BremStrahlung photon associated with the charged track. A 3% misidentification rate is expected for a 95% electron identification efficiency. Good electron ID is needed for the flavor tagging of semi-leptonic B decay and gives access to several B decay modes, such as $B \to K^*e^+e^-$ or $B \to J/\Psi(e^+e^-)K_s$. The muon identification is dominated by the information from the muon chambers which provides a 1% misidentification rate for a 95% identification efficiency.

4.3 The proper time measurement

The measurement of the proper time of the decaying B is a key ingredient in the many LHCb's core analyses. The LHCb Vertex Locator is a silicon strip detector with the first measurement at a radius of 8.2 mm from the beam and has a hit resolution of better than 10 μm. It provides a precise impact parameter determination with an expected resolution of 14 μm + $35/p_T$ (p_T in GeV/c) which allows for efficient rejection of combinatorial background arising from particles coming from the primary vertex. The primary vertex position is reconstructed with a 50 μm resolution along the beam axis (z-axis) and 5-10 μm transverse to the beam direction. Displaced vertices are reconstructed with a precision along the z-axis of about 150 μm as compared to the 1 cm average flight distance for B mesons in LHCb. When the position uncertainty is combined with the precision of the momentum measurement, it results in a decay time resolution of about 40 fs for B mesons decaying into charged particles only, and about 80 fs for radiative B decay or B decays with an energetic π^0 .

This excellent proper time resolution is critical to resolve the fast oscillations of B_s mesons, which is a key ingredient to many of the time-dependent CP measurements in B_s decays. This time resolution can be accurately extracted from the analysis of $B_s \to D_s\pi$ decays (170×10^3 selected event expected each year), which would then be directly applicable to $B_s \to D_sK$, for example.

4.4 Flavor tagging

In addition to excellent proper time resolution, CP asymmetries also rely on tagging the flavor of the B meson at production (so called, flavor tagging). LHCb applies the classical flavor tagging techniques, combining the information from the opposite-side b (kaon-tag from $b \to c \to s$ cascade, lepton-tag for semi-leptonic B decay and global vertex-charge) and the fragmentation information from the signal side b. Unlike the B-factories operating at the $\Upsilon(4S)$, the tagging B produced in hadronic collisions oscillate incoherently : almost 50% of the tagging-b form a neutral B meson, including 10% to the rapidly oscillating B_s, and thus contribute to the dilution of the b-tagging power. LHCb's RICH detectors provides excellent kaon-tagging for both the opposite-side (both B and B_s) and the same-side tagging in case of a B_s. As an illustration, the tagging efficiency for the $B_s \to J/\Psi\Phi$ decay is 55% with a wrong tagging rate of 33%, resulting in a tagging power of 6.2%, half of which comes from the kaon-tag information. The typical tagging power for B_d decay is slightly lower, at the level of 5%, due to the reduced power of the same-side tagging with pions.

The extraction of the tagging performance from the data is likely to come first for the opposite-side taggers, as there are higher statistics for B_u and B_d channels with respect to B_s. From the self tagging $B_d \to J/\Psi K^*$ decay, the wrong tagging rate canb be extracted from the data with a 0.3% statistical uncertainty with one nominal year of data taking.

5. Probing flavor physics

5.1 Measuring a branching ratio of a very rare decay : $B_s \to \mu^+\mu^-$

The $B_s \to \mu^+\mu^-$ decay is a FCNC transition dominated by the Z-penguin diagram. It's rate is well predicted by the SM [2] and is expected to have a branching ratio of $(3.291^{+0.094}_{-0.267})10^{-9}$.

New Physics particle entering into the loop can modify significantly this branching ratio. This decay is thus an efficient probe for New Physics. The LHCb selection for $B_s \to \mu^+\mu^-$ is based on a 3-dimensional likelihood [3]. The first likelihood dimension combines the various geometrical information on the decay (impact parameter, B_s decay length, vertex isolation, etc) and is illustrated in Figure 5. The other two dimensions rely on the reconstructed B_s mass and the muon-identification, respectively. The likelihood distributions are fully determined from the data in order to limit the Monte-Carlo dependence of the analysis. Reconstructed mass side-bands are used to determine the background distributions and the signal distributions will be evaluated using control channels including $B_{(s)} \to h^+h^-$ or $B_d \to J/\Psi(\mu\mu)K_s$.

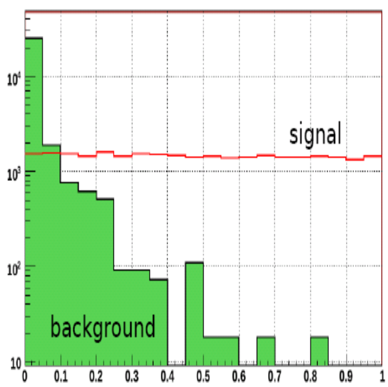

Figure 5: Geometrical Likelihood distribution for $\mu^+\mu^-$ signal and background.

Channels with known branching fractions will be used to derive the absolute branching fraction from the yield of selected events. The trigger efficiency and tracking efficiencies are normalized using $B_d \to K\pi$ and $B_u \to J/\Psi(\mu\mu)K^-$. The main systematics (13%) come from the ratio of hadronization rates of the B_s relative to the B_d and B_u mesons ($f_{B_s}/f_{B_{d,u}}$). The likelihood distribution are analyzed on a statistical basis to extract the results shown in Figure 6. With an accumulated luminosity as small as 0.1 fb^{-1}, LHCb is expected to reach the final combined limit from the Tevatron [4]. A 3σ evidence of the Standard Model branching ratio could show up with one nominal year of data taking and a 5σ observation in several years.

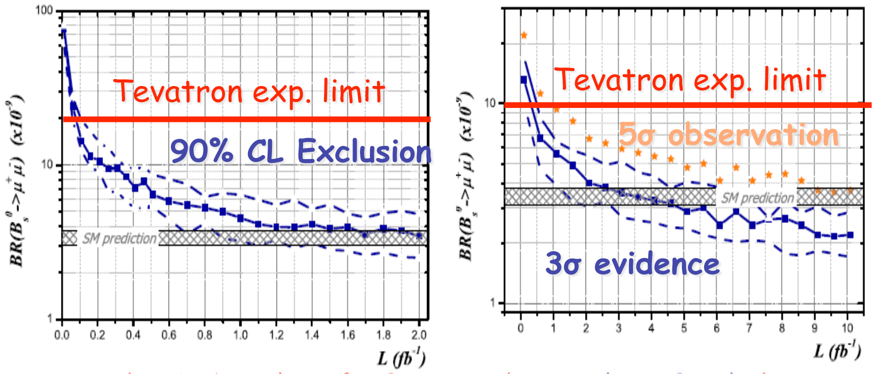

Figure 6: 90% CL upper limit on the $B_s \to \mu^+\mu^-$ branching ratio (left) and 3σ evidence and 5σ observation (right) as a function of the integrated luminosity. The expected Tevatron performance is shown.

5.2 Measuring a time-dependent decay rate : the photon polarisation in $B_s \to \Phi\gamma$

Another probe of New Physics is the measurement of the photon polarization in the radiative $b \to q\gamma$ penguin transition. In the Standard Model the photon from $b \to s\gamma$ is mostly left-handed. The right-handed component is suppressed by the ratio of the strange quark mass to the b-quark mass. The time-dependent decay rate of the radiative decay for initial B_q, $\bar{B}_q \to f^{CP}\gamma$, where f_{CP} is a CP eigenstate, exhibits a term, A_q^{Δ}, dependent on the fraction of wrong photon polarization.

$$\Gamma(B_q(\bar{B}_q) \to f^{CP}\gamma) = \|A\|^2 \, e^{-\Gamma_q\tau}[cosh(\Delta_q\tau/2) + A_q^{\Delta}sinh(\Delta_q\tau/2) \pm C_q cos(\Delta m_q\tau) \mp S_q sin(\Delta m_q\tau)]$$

Within the Standard Model, and in the case of the B_s meson one expects the time dependent and time-independent asymmetry terms, S_s and C_s, almost to vanish. The large lifetime difference for B_s ensures some sensitivity to the polarization amplitude ratio, A_q^{Δ}. The reliable SM prediction [6] at the next-to-next leading order for this polarization term can be confronted with the experimental data to check for New Physics in loop.
Approximately 11×10^3 $B_s \to \Phi\gamma$ signal events are expected to be recosntructed and selected with LHCb per nominal year of data taking with a background over signal ratio of less than 90% [5]. From the flavour-tagged time-dependent decay rate, the polarization amplitude and the asymmetry parameters can be simultaneously obtained. The background is parametrized from the reconstructed mass side-bands and the proper-time acceptance from the control channels $B_d \to K^*\gamma$ and $B_s \to J/\Psi\Phi$. A resolution of 0.22 is expected on the polarization amplitude and 0.1 for the asymmetry parameters, C_s and S_s with one nominal year of data taking.

5.3 A Dalitz plot analysis : the UT angle γ from $B^- \to D^0(K_s\pi^+\pi^-)K^-$

An important goal of the LHCb experiment is to precisely determine the Unitarity Triangle angle γ. This phase can be measured, for instance, through the interference between the $b \to c$ and

$b \to u$ transitions in $B^- \to DK^-$.

Among several methods, a possible technique to extract simultaneously the weak phase γ, the strong phases and the decay amplitudes ratio, is to perform a Dalitz plot analysis of the D^0 and $\bar{D}^0$ 3-body decay into $K_s\pi^+\pi^-$.

With the nominal annual luminosity of 2 fb^{-1}, 5×10^3 signal events are expected to be selected in LHCb with a background over signal ratio less than 70% [7]. The angle γ can be extracted using an unbinned amplitude fit, assuming an isobar model for the various resonances entering in the Dalitz plot. With this method a statistical resolution at the level of 10 degrees can be achieved on γ together with a 7 degrees systematics uncertainty due to the modeling of the intermediate resonances. To limit the model dependence, a binned fit using inputs on the strong phase shifts from the correlated $\Psi \to D^0\bar{D}^0$ decay at CLEO-c can be done. It results in a significant reduction in the systematics uncertainty, at the level of 1-2 degrees, and thus will be of great importance when the statistical precision approaches 10 degrees. This Dalitz method can be extended to other D^0 decays, such as K_sKK or $K_sK\pi$. In addition, there are several other methods to extract the γ angle from tree processes [7]. Combining all these techniques the LHCb resolution on γ is expected to reach the 5 degrees level with an integrated luminosity of $2 fb^{-1}$. The impact of such a measurement on the global CKM fit is illustrated in Figure 7.

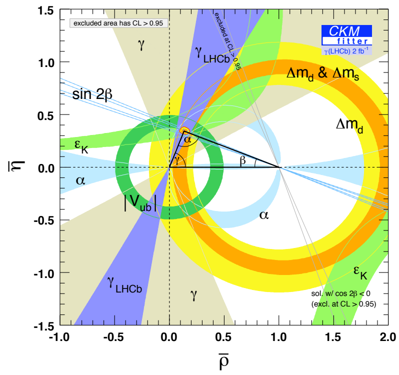

Figure 7: Constraints in the $(\bar{\rho},\bar{\eta})$ plane from the global CKM fit of the current data. The expected constraint from γ with 1 nominal year of LHCb data taking is superimposed.

5.4 The forward-backward asymmetry from the angular analysis of the $B_d \to K*\mu\mu$ decay.

The $B_d \to K^*\mu^+\mu^-$ decay proceeds via the suppressed FCNC $b \to s$ Electroweak-penguin transition with a measured branching fraction $(1.03^{+0.26}_{-0.23})10^{-6}$ [8] in good agreement with the SM expectation. The dynamics of this decay are very sensitive to any New Physics particles that possibly enters into the flavor-changing loop. In particular the lepton angular distribution in the di-lepton rest-frame with respect to the B momentum is expected to be significantly modified by many New Physics scenarios. There are severable observables to test the decay dynamics, including the muon forward-backward asymmetry as a function of the di-muon invariant mass squared. The zero-crossing point of this asymmetry could discriminate between several New Phyics models as illustrated in the left part of Figure 8.

The Standard Model prediction for the zero-crossing point of this asymmetry depends on the Wilson Coefficients, C_7 and C_9 and is predicted to be $m^2_{\mu\mu}(0) = (4.36^{+0.33}_{-0.31})GeV^2/c^4$ [9]. About 7×10^3 signal events are expected to be selected per nominal year with a background over signal ratio of less than 20% in LHCb [10]. The expected resolution on the zero-crossing point is 0.5 GeV^2/c^4. A full angular analysis of the decay with high statistics is expected to provide a better discrimination between the New Physics models.

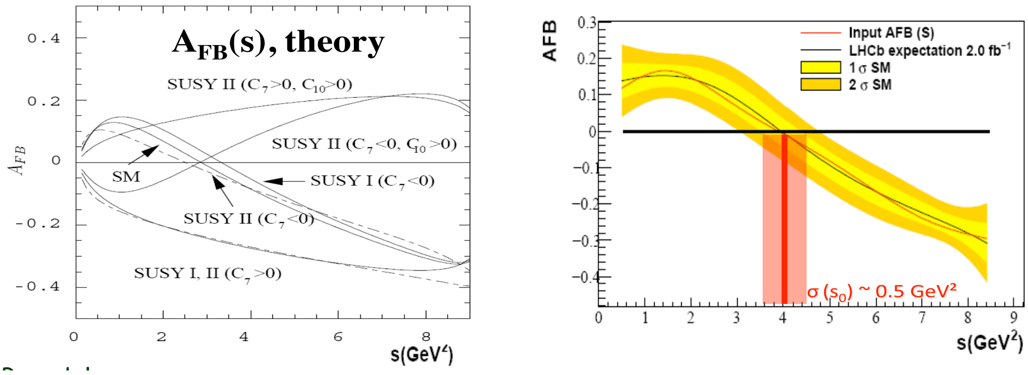

Figure 8: Muon forward-backward asymmetry in the $B_d \to K^* \mu^+ \mu^-$ decay as a function of the di-muon invariant mass for the Standard Model and various SUSY models (left) and the expected LHCb measurement performance (right).

5.5 A time-dependent flavor-tagged angular analysis : the UT angle β_s from $B_s \to J/\Psi\Phi$

The $B_s \to J/\Psi\Phi$ decay data allow for the extraction the B_s mixing phase, ϕ_s, with respect to the $b \to c$ decay phase, from an almost pure $b \to ccs$ tree transition, and thus is sensitive to New Physics in the B_s box diagram.

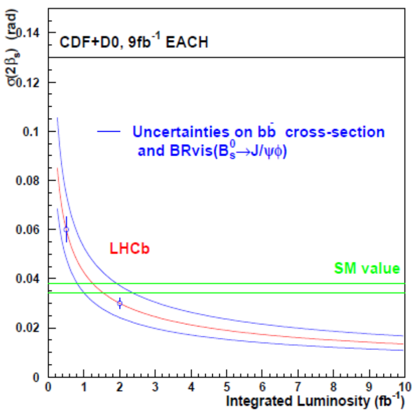

Figure 9: LHCb expected resolution on the mixing phase $2\beta_s$ from $B_s \to J/\Psi\Phi$ as a function of the luminosity.

The expected small value of the B_s mixing phase is well determined within the Standard Model by the CKM metrology : $\phi_s = -2\beta_s = 0.0362 \pm 0.0018$ [2]. The large central value recently observed in the direct measurement by the CDF and D0 experiments, $\Phi_{J/\Psi\Phi} = 0.76 \pm 0.36$ [11] deviates by more than 2σ with respect to the Standard Model expectation. This decay is thus an important channel to be analyzed by LHCb [12].

As in any vector-vector final state in a B decay, the $J/\Psi\Phi$ is not a pure CP-eigenstates. An angular analysis is needed to separate on a statistical basis the CP-odd from the CP-even components. A large yield of about 120,000 signal events is expected to be collected per year with a background over signal ratio of about 2. An unbinned likelihood fit to the time dependent decay rates for the initial B_s and $\bar{B}_s$ allows one to extract the mixing phase ϕ_s together with the lifetime and the even and odd components' parameters. A resolution on ϕ_s of 0.03 radians can be expected with $2 fb^{-1}$. The expected resolution on ϕ_s as a function of the integrated luminosity is displayed in Figure 9. This analysis requires an accurate control of the acceptance, of the flavor tagging and of the background level. This is to be done using the control channels $B \to J/\Psi K^*$, $B^+ \to J/\Psi K^+$ and $B_s \to D_s^* \pi$, and the selected signal mass side-bands.

A similar analysis can be done with the pure $b \to sss$ gluonic penguin transition, $B_s \to \Phi\Phi$. The dependency on V_{ts} in both the mixing and the decay amplitudes leads to a cancellation of the

B_s mixing phase in this decay. Therefore, if any significant phase is measured, this would be a clear signature of New Physics. Almost 4×10^3 events are to be selected each year leading to a statisical resolution of 0.1 on the phase $\phi_{\Phi\Phi}$.

6. Conclusions

The LHCb detector is a dedicated experiment to search for New Physics in the decay of heavy flavors. It aims at performing high precision measurements in the challenging environment of the hadronic collisions of the LHC. As briefly outlined in this document, sophisticated techniques for the reconstruction of the final state and for their analysis are in place. Important results, such as the improvement on the limit on the $B_s \to \mu^+\mu^-$ branching fraction and on the measurement of the B_s mixing phase are expected to come soon after the LHC startup. The physics program of LHCb covers a much wider range than the few key analysis discussed in Section 5 of this proceeding.
With LHCb, we hope to make a great step forward in our understanding of the dynamics of the heavy flavor decays and uncover an indirect manifestation of physics beyond the Standard Model.

7. Acknowledgements

My warmest thanks go to my collaborators of the LHCb collaboration for their support in the preparation of this talk. I also would like to thank the organizers of the FPCP09 conference for their kind hospitality in Lake Placid, NY.

References

[1] LHCb Collaboration , "The LHCb Detector at the LHC", Journal of Instrumentation, 2008 JINST 3 S08005;

[2] Valentin Niess., "CKM fits", this proceedings;
The CKMfitter group, http://ckmfitter.in2p3.fr/;

[3] D. S. Santos et al., "Analysis of the decay $B_s^0 \to \mu^+\mu^-$ at LHCb", LHCB-ROADMAP1, in preparation

[4] T. Aaltonen et al. [CDF collaboration], Phys. Rev. Lett. 100 (2008) 101802; D0 collaboration, D0 note 5344-CONF (2007);

[5] S. Barsuk et al., "Roadmap for the radiative decays of beauty hadrons at LHCb", LHCB-ROADMAP4, in preparation;

[6] D. Atwood, M. Gronau and A. Soni, Phys. Rev. Lett. 79 (1997) 185;

[7] M. Adinolfi et al., "The tree-level determination of gamma at LHCb ", LHCB-ROADMAP5, in preparation;

[8] C. Amsler et al., Physics Letters B667, 1 (2008);

[9] M. Beneke et al., "Exclusive radiative and electroweak Bd and Bs penguin decays at NLO", Eur.Phys.J.C41:173-188,2005;

[10] J. Dickens et al.,"Roadmap for the analysis of $B_d^0 \to K^{*0}\mu^+\mu^-$ at LHCb", LHCB-ROADMAP2, in preparation;

[11] The CDF Collaboration (T. Aaltonen, et al.),Phys. Rev. Lett. 100, 161802 (2008);
The D0 Collaboration (V.M. Abazov, et al.), arXiv:0802.2255 [hep-ex] (2008);

[12] J. Albrecht et al.,"Roadmap for the measurement of mixing induced CP violation in $B_s^0 \to J/\Psi\Phi$ at LHCb", LHCB-ROADMAP3-001, in preparation;