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Abstract

Three experiments, among the LHC project, are getting ready to explore the b quark flavour sector. While ATLAS and CMS are general purpose experiments, where the study of B mesons is going to proceed in parallel with the Higgs boson and supersymmetry searches, the LHCb experiment is devoted to B physics studies. The key parameters entering the physics analyses and the performances achieved in all the three experiments are presented. Given the large B physics program foreseen in the LHC experiments, the studies reported in this paper have been selected as those with higher likelihood to provide solid and interesting new results on Standard Model validation and New Physics processes search with early data.

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1 Introduction

In the context of the large effort performed within the LHC (1) experiments in order to finalize the construction of the Standard Model (SM) and to shed some light on the building blocks of its future extension, the B physics program plays a very important role.

In a complementary way to the direct searches of Higgs boson(s) and new particles, the New Physics (NP) processes can be studied by making precision measurements in the flavour sector, where we do expect significant effects if the NP scale is not completely decoupled from the TeV energy range.

In this framework, the B meson system is a natural place where to look. The B_d mesons properties have already been studied in detail by the B-factories experiments (CLEO, BaBar, Belle) yielding an impressive agreement with the SM expectations. The properties of the B_s mesons, not available at e^+e^- colliders¹, are much less constrained and there's still room to account for significant contributions from NP effects. Moreover, the study of the B system with high statistics samples of different b hadrons can be used to further constrain the SM CP violation mechanism described by the Cabibbo-Kobayashi-Maskawa (CKM) matrix.

Three LHC experiments, LHCb (2) ATLAS (3) and CMS (4), have defined a research program that includes the search of rare decays and NP signatures through precision measurements of the meson decays.

While LHCb (2) is devoted and optimized for the measurement of the B meson properties, the other two are general purpose experiments where the study of B mesons proceeds in parallel with the Higgs boson and supersymmetry searches.

The doability of such B physics programs at the hadron machines is demonstrated by the recent results of Tevatron experiments (CDF, D0 (5)) with their nice measurements of Δm_s (6) and $\Delta\Gamma_s$ and ϕ_s (7).

The LHC environment, the expected resolutions of the various detectors and their triggering strategies are reviewed in section 2, while section 3 contains the detail description of the physics program and of the expected performances that can be achieved with the data samples collected during the first year of operation of LHC.

2 LHC detectors for B physics

The parameters summarizing the LHC environment for B physics studies (center of mass energy, cross sections, luminosity) are reported in Table 1 for the LHCb, ATLAS and CMS experiments.

The very large cross section for $b\bar{b}$ production, yielding $O(10^4)$ $b\bar{b}$ pairs per second ($L = 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$) with all the b-hadrons species being produced, extend down to 10^{-9} the Branching Ratio (BR) measurement capability for the rare B decays.

For this aim a huge effort is needed in order to reduce the large background coming from the pp interactions, whose production cross section is two orders of magnitude higher than the b quarks production one.

Attention should also be paid to the choice of running luminosity (L): while larger L provides larger data samples, the number of interactions per crossing increase rapidly with L, creating problems to the B hadron reconstruction and identification (see Table 1).

The main difference in the visible cross section between the LHCb detector, a single arm forward spectrometer accepting events with $1.8 < |\eta| < 5$, and the ATLAS/CMS detectors, that are accepting events with $|\eta| < 2.5$, comes from the lower p_T threshold that can be achieved in the former. The production of $b\bar{b}$ pairs in LHC, according to PYTHIA simulations, occurs with the $b\bar{b}$ pairs highly collimated (as shown in Figure 1): this also favors the LHCb forward design with respect to the 4π design of the others two experiments.

The main experimental ingredients entering the B mesons decays study, like the tracking, particle identification and tagging performances and proper time measurements, are presented in detail in the next paragraphs, as well as the currently implemented trigger strategies.

2.1 Tracking

The track reconstruction performance is of primary importance in the various steps of the B meson decays analysis: the capability of triggering interesting events, the event selection and background suppression.

¹The Belle experiment, since last year, started a physics program at the $\Upsilon(5S)$. The small statistics of B_s mesons collected, will mainly be used to measure some absolute branching ratios.

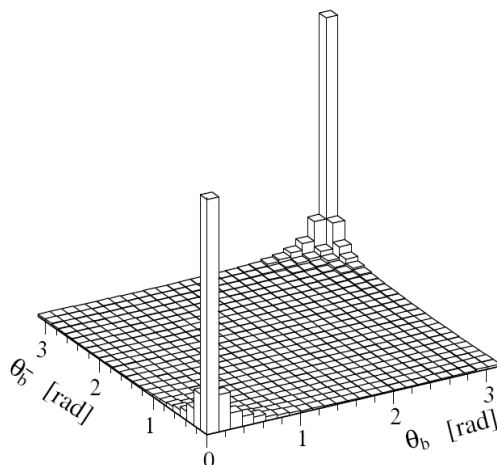


Figure 1 Production angle of B vs. angle of B in the laboratory (in units of rad.), calculated using PYTHIA. The peaks in the forward directions shows the correlation between their respective production directions.

Table 1 Center of mass energy, cross sections, luminosity and number of interactions per crossing expected in the LHCb, ATLAS and CMS experiments.

Parameter	LHCb	ATLAS,CMS
Energy (TeV)	14	14
$\sigma(pp)$ (mb)	100	100
$\sigma(b\bar{b})$ μb	500	500
Visible $\sigma(b\bar{b})$ μb	230	100
L ($\text{cm}^{-2} \text{s}^{-1}$)	$2 \cdot 10^{32}$	$1 \cdot 10^{34}$
# _{int} /crossing	1	23

In the ATLAS and CMS detectors a large part of the B physics program is performed using channels involving muons, either as the particles triggering the acquisition (high p_T tracks) or in the final states (J/ψ decays). The high overall muon reconstruction efficiency (>98%, CMS) achieved is due to the good muon transverse momentum resolution (1–2%) and impact parameter resolution (10 μm) in the trackers.

The LHCb detector is able to use kaons and pions in the trigger, in addition to the electrons and muons that are available also in ATLAS and CMS. The expected performances are: a relative momentum resolution in the range 0.3–0.5% depending on the track momentum and a very high reconstruction efficiency (>95%) for particles travelling in the whole detector with a small (<4%) contamination of ghost tracks (having applied a $p_T > 0.5 \text{ GeV}/c$ cut).

The track impact parameter resolution is $\sim 30 \mu\text{m}$ and the typical B meson mass resolution, obtained in some benchmark channels studying the reconstruction of fully simulated events, are given in Table 2. Those values are remarkable when considering the very high charged particles multiplicity environment of the experiment: ~ 70 charged particles are expected for each $b\bar{b}$ event at nominal luminosity (see Table 1).

2.2 Particle Identification

While the ATLAS and CMS detectors are concentrating all the efforts on the analysis of B meson decays involving muons, the LHCb experiment is able to identify also kaons and pions by means of two Cerenkov detectors: the RICH1 and RICH2. The combined information coming from those two

Table 2 Typical B mesons mass and proper time resolutions in the LHCb experiment. The last row contains the value obtained for the B_s meson mass resolution after having applied a mass constraint on the J/ψ .

Parameter	Value
Proper time	40 fs
Mass ($B_s \rightarrow \mu\mu$)	18 MeV/c ²
Mass ($B_s \rightarrow D_s\pi$)	14 MeV/c ²
Mass ($B_s \rightarrow J/\psi\phi$)	14 MeV/c ²
Mass ($B_s \rightarrow J/\psi\phi$)	8 MeV/c ²

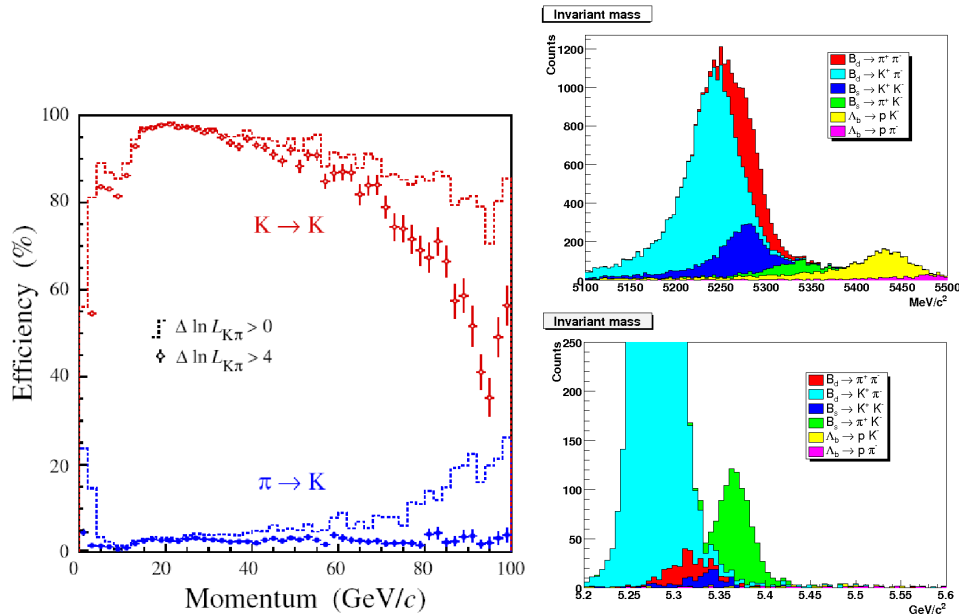


Figure 2 The efficiency (above 30%) and misidentification (below 30%) distributions for two different delta log likelihood cuts, $\Delta \ln L_{K\pi} > 0$ as shown with the dashed line and $\Delta \ln L_{K\pi} > 4$ shown with the open dots, in the kinematic range 0 to 100 GeV/c. Right: B to hh mass spectra before (left) and after (right) the use of particle ID information for the selection of the $B_s \rightarrow K\pi$ decay.

detectors is used to achieve a very good π, K separation in a wide kinematic range (2-100 GeV/c). The LHCb efficiency and misidentification distributions are shown in the left plot of Figure 2. These quantities will be calibrated with data using pions and kaons from the $D^{*+} \rightarrow D^0(K^-\pi^+)\pi^+$ decay (expected rate: 16 Hz), where a very pure sample of kaons and pions can be selected using only kinematic cuts.

The LHCb capability of identifying pions and kaons enhance the B physics program richness allowing the analysis of non leptonic channels, like the $B \rightarrow hh$ or $B \rightarrow \phi\phi$ ones. These channels can be used to improve the knowledge of the U spin symmetry breaking, to constrain the CKM angle γ (see par. 3.4) or to measure the CKM angle ϕ_s (see par. 3.1)

The separation of the several contributions ($\pi\pi$, $K\pi$, KK channels) in the $B \rightarrow hh$ analysis can be achieved in LHCb only thanks to the excellent particle identification (PID) performance: see for example the $B \rightarrow hh$ mass spectra in the right up (down) plots of Figure 2 obtained before (after) the use of PID information for the selection of the $B_s \rightarrow K\pi$ decay.

The muon identification in LHCb is provided by the muon system, achieving a very high reconstruction efficiency ($\epsilon > 95\%$) with a low misidentification ($\leq 1\%$ for $p > 10$ GeV/c). These performances will be calibrated and measured on data using dedicated samples. The muon PID can use the generic

μ (50 Hz), prompt J/Ψ (2 Hz) and J/Ψ from B (0.03 Hz) events while the misidentification can be measured using Λ decays that provide a clean sample of protons and pions using only kinematic constraints and the hadrons reconstructed in the $B \rightarrow hh$ decay chain (0.02 Hz).

2.3 Tagging

The tagging performances are determined using different strategies and algorithms exploiting the detector capabilities in the different experiments. These performances are expressed in terms of the effective tagging efficiency (ϵ_{eff}) defined as $\epsilon_{eff} = \epsilon_{tag}(1 - \omega)^2$, where ϵ_{tag} is the tagging efficiency (probability that the tagging procedure gives an answer) and ω is the wrong tag fraction (probability for the answer to be incorrect when a tag is present).

The ATLAS experiment quotes an $\epsilon_{eff} = 4.6\%$ using the lepton and jet charge tagging algorithms on the opposite side candidates, while the CMS experiment is still developing the tagging strategy to assess the tagging performance. The LHCb experiment is also using the kaon tagging from the opposite side B and the pions (B_d) or kaons (B_s) taggers from the same side as the signal candidate, achieving an overall $\epsilon_{eff} = 6.6\%$. The tagging performances will be evaluated with data by using control channels like $B^+ \rightarrow D^0 \pi^+$.

2.4 Proper Time Measurement

The ability to measure the distance of flight of the B meson, that is translated into the proper time using the momentum information, is of crucial importance in CP analyses. Since the B_s mesons are oscillating faster than the B_d ones (CDF and D0 measure $\Delta m_s = 17.77 \text{ ps}^{-1}$ in good agreement with the expected SM value) a good proper time resolution (σ_t) is important in order to resolve the oscillations. The proper time resolution expected for the ATLAS (83 fs) and CMS (77 fs) experiments is much larger than the one expected in LHCb (36 fs): these values will be measured using the B mesons lifetimes and, whenever possible, control channels. For example in LHCb the $B_s \rightarrow D_s^+ \pi^-$ decays can be used to get a clean measurement of Δm_s and of the B_s oscillations, extracting the proper time resolution.

2.5 B Physics Triggers

In order to reduce the high rate of events coming from the pp collisions selecting only those that are likely to contain a B meson, dedicated trigger algorithms are needed. The three LHC experiments are using a similar approach: a first level trigger, hardware based, is used for the fast selection of high p_T events, while a second level trigger, software based, is used to reduce the event rate to an acceptable amount while keeping a maximum efficiency for signal events.

The ATLAS and CMS first level (L1) trigger has an output rate of <100 kHz and uses the information from the muon chambers and the calorimeters to select high p_T muons. The LHCb first level (L0) trigger has a 1 MHz output rate and uses the input from the muon system, the calorimeters and the pileup system in order to select h, μ , e, γ and π^0 over a minimum p_T threshold. The L0 trigger efficiency (ϵ_{L0}) is $>80\%$ for channels with J/Ψ , while $\sim 40\%$ for other hadronic channels.

The software trigger for the LHC experiments is executed after the full event readout. ATLAS and CMS experiments have an overall output rate of 200 Hz: only $\sim 10\%$ of these events can be used for B physics studies. In addition, for the study of leptonic decays, $O(1)$ kHz bandwidth of di- μ events is available.

The LHCb High Level Trigger (HLT) has an output rate of 2 kHz. Starting from the L0 confirmation the trigger bandwidth is divided between inclusive and exclusive selections as follows: 200 Hz is the bandwidth allocated for the core B physics program (exclusive reconstruction), 600 Hz are devoted to the reconstruction of high mass dimuons events (allowing for an unbiased proper time selection of J/Ψ decays), 900 Hz are available for an inclusive B meson selection using semileptonic decays ($B \rightarrow \mu$) mainly devoted to data mining studies and the remaining 300 Hz will be used for the D^* reconstruction to be used for the particle ID calibration and charm studies.

3 B physics program

The B physics program of the ATLAS, CMS and LHCb experiments covers several different areas: from the cross section to the leptonic decays studies, from the rare decays to the CP violation studies, from the NP searches to the search of new particles through the Dalitz analysis and data mining.

All the studies reported here have been performed on events coming from the standard simulation, digitization and reconstruction experiments software. The statistics used to quote the results, unless specified otherwise, do refer to one fourth of a nominal year running: 2.5 fb^{-1} for ATLAS and CMS and 0.5 fb^{-1} for LHCb. These data samples will be likely available in 2009.

Only few topics have been chosen and will be reported here: the study of $b \rightarrow s$ transitions in the $B_s \rightarrow J/\Psi\phi$ channel, $b \rightarrow sll$ decays, the measurement of the $B_s \rightarrow \mu\mu$ branching ratio, the measurement of the CKM angle γ and of the B production cross sections.

3.1 $B_s \rightarrow J/\Psi\phi$

The study of the $B_s \rightarrow J/\Psi\phi$ decays can be used to measure the CKM angle ϕ_s , predicted to be very small by the SM:

$$\phi_s[SM] = \text{arg}(V_{ts}^2) = 2\lambda^2\eta = 0.0368 \pm 0.0018 \quad (1)$$

and hence sensible to NP processes that could give measurable contributions.

From the experimental point of view this decay is particularly suited for the detection and reconstruction in all the LHC experiments, since it involves 2 muons from the J/Ψ decay, allowing an efficient trigger, and has an high predicted BR: $\sim 3 \cdot 10^{-5}$.

The value of $\phi_s(-2\beta_s)$ can be extracted from the measurement of the time dependent CP asymmetries $A_{CP}(t)$:

$$A_{CP}(t) = \frac{-\eta_f \sin\beta_s \sin(\Delta m_s t)}{\cosh(\Delta\Gamma_s t/2) - \eta_f \cos\beta_s \sinh(\Delta\Gamma_s t/2)} \quad (2)$$

where $\eta_f = 1(-1)$ for odd(even) CP states. Since the decay final state is not a pure CP eigenstate, an angular analysis is needed that involves the three angles θ_ϕ , θ_{tr} , ϕ_{tr} defined as shown in Figure 3. Together with the angles, the measurement of the B_s candidates mass, proper time and tagging informations are needed as input to the analysis.

The sensitivity to the ϕ_s angle heavily depends on the tagging performance (entering through the ϵ_{eff} term) and the proper time resolution: the different detectors performances have been already reported in paragraphs 2.3 and 2.4.

The specific cuts, used in the selections of the signal events, are described in (8). The number of reconstructed events is shown in the first row of Table 3, while the number of the flavour tagged events is given in the second row.

The candidates have mass resolutions of $\sim 15 \text{ MeV}/c^2$ with background over signal ratios (B/S) in the range 0.25–0.12 (see the third and fourth rows in Table 3). It should be noted that the LHCb result is obtained without using the J/Ψ mass constraint allowing a better background control.

The resolutions on ϕ_s and $\Delta\Gamma_s$, that can be achieved with data collected during 2009 are shown in the last two columns of Table 3.

With the quoted values, LHCb is able to exclude/measure NP contributions to ϕ_s beyond the SM (see for example (9) for a discussion of the impact of LHCb measurement of ϕ_s in constraining NP contributions to $b \rightarrow s$ transitions). Further improvements could also come by adding other decay channels, like $J/\Psi\eta$, $\eta_c\phi$ or $D_s^+ D_s^-$, to the ϕ_s analysis. By 2013, ATLAS and CMS are expected to achieve the SM level sensitivity, while LHCb will test the SM prediction at the 5σ level.

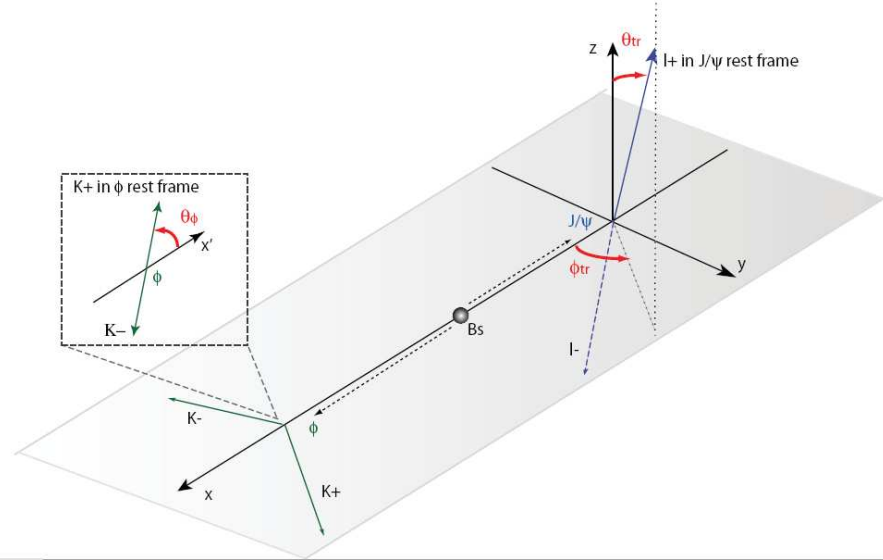


Figure 3 Definition of angles θ_ϕ , θ_{tr} and ϕ_{tr} , used in the three angle analysis of the $B_s \rightarrow J/\Psi\phi$ decay.

Table 3 B mass resolutions, B/S ratios and number of selected events for the analysis of $B_s \rightarrow J/\Psi\phi$ events in the LHC experiments.

Parameter	ATLAS	CMS	LHCb
N_{rec}	23k	27k	33k
$N_{rec}^{eff-tag}$	1 k	-	2.2 k
σ_m [MeV/c ²]	16.5	14	14
B/S	0.18	0.25	0.12
$\sigma(\phi_s)$	0.159	-	0.042
$\sigma(\Delta\Gamma_s)/\Delta\Gamma_s$	0.41	0.13	0.12

3.2 $B_s \rightarrow \mu\mu$

The $B_s \rightarrow \mu\mu$ decay is predicted in the SM to be very rare, since it involves flavour changing neutral currents and experiences a large helicity suppression ($\sim m_\mu/m_b$), with a BR at the level of 10^{-9} .

Various attempts have already been made to measure the BR: the current experimental situation, concerning both B_d and B_s decays, is summarized in Figure 4 where the current best limits are coming from CDF (10) (BR < $4.7 \cdot 10^{-8}$ @90% CL) and D0 (11) (BR < $7.5 \cdot 10^{-8}$ @90% CL) measurements.

The study of this decay is of particular interest when probing NP models, like the MSSM, that allows for large modifications of the BR: the contribution of a $\tan^6\beta/M_A^4$ term, for example, can significantly enhance the measured value if the $\tan\beta$ value is large, as suggested by other experimental results like $b \rightarrow s\gamma$, $(g-2)_\mu$ and $B \rightarrow \tau\nu$.

The measurement of the $B_s \rightarrow \mu\mu$ BR can thus play a major role in constraining/measuring the NP contributions and even help selecting/ruling out a given theoretical model (12).

The analysis strategies pursued are different in LHCb (13) and in ATLAS and CMS (14). In the LHCb approach the topological informations are used to build a geometrical likelihood for each event (GL). Then the three dimensional space built with the GL, mass and particle ID informations is divided for all the events in N bins. For each bin the expected number of events for the signal and for the signal plus background hypothesis are computed and used to place a limit (or evaluate the measurement sensitivity) on the BR.

The ATLAS and CMS experiments are instead using a cut and counting approach. The geometrical and particle ID informations are used to select the events by applying cuts. The mass distribution

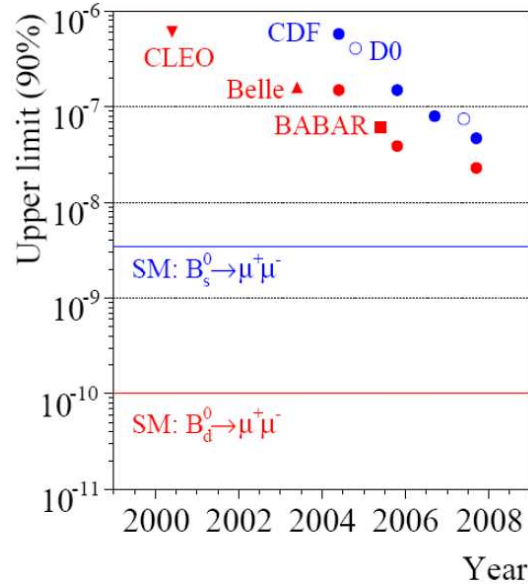


Figure 4 Current experimental overview of $B_s \rightarrow \mu\mu$ (blue/darker markers) and $B_d \rightarrow \mu\mu$ (red/lighter markers) BR measurements, as a function of time.

Table 4 Expected B meson mass resolutions and number of signal and background events obtained in the study of $B_s \rightarrow \mu\mu$ decays for the different LHC experiments.

Parameter	ATLAS	CMS	LHCb
$\sigma_m [\text{MeV}/c^2]$	67	43	20
N_{sig}	7	6	30
N_{bkg}	20	14	83

is then used to count the events: CMS opens a $\pm 2.3 \sigma$ window, while ATLAS performs a bayesian number of events estimate.

The normalization channel used in the BR measurement is the $B^+ \rightarrow J/\Psi K^+$: one million of such events is expected for each fb^{-1} of data in all the LHC experiments. The LHCb experiment also foresees the use of $B \rightarrow hh$ decays as a control channel, while the background will be extracted from the side bands.

The expected number of events after a nominal year of running (2 fb^{-1} LHCb, 10 fb^{-1} ATLAS and CMS) is quoted in the second and third rows of Table 4. The sensitivities of LHCb as a function of the integrated luminosity are given in Figure 5, while the ATLAS result is shown in Figure 6.

The LHCb experiment has the potential of measuring a BR of $9(15) \cdot 10^{-9}$ at $3(5)\sigma$ level with 0.1 fb^{-1} of data and $5(9) \cdot 10^{-9}$ with 0.5 fb^{-1} . The SM BR can be assessed with a $3(5)\sigma$ evidence (observation) with $2(6) \text{ fb}^{-1}$.

The ATLAS and CMS experiments, when properly rescaling the integrated luminosity, are contributing with comparable performances.

3.3 $b \rightarrow sll$ decays

The study of exclusive $b \rightarrow sll$ decays is another way to look for NP effects in $b \rightarrow s$ transitions at an hadron collider: the leptons in the decay provide an efficient trigger while the exclusive reconstruction reduce the background contribution.

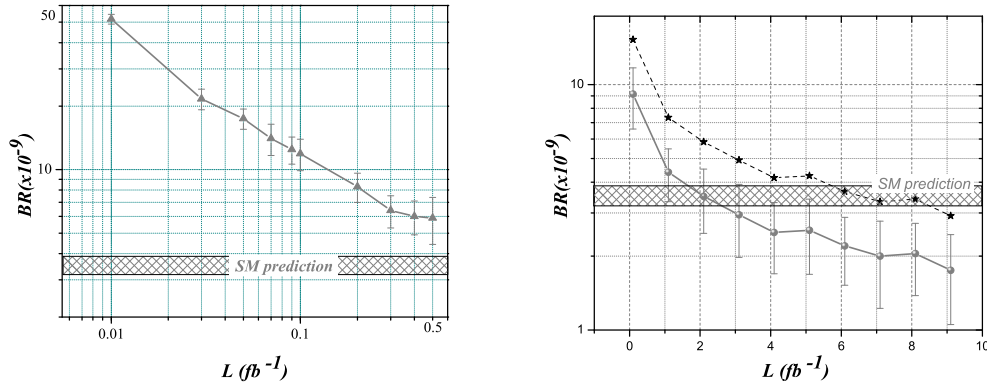


Figure 5 Left: $BR(B_s^0 \rightarrow \mu^+ \mu^-)$ excluded at 90% CL as a function of the integrated luminosity (L) if no signal is present. Right: Luminosity needed for the observation of a given BR at 3σ (grey circles) and 5σ (black stars) level.

These semileptonic decays proceed through suppressed loops in SM and thus are sensitive to NP contributions, that can be of SM size, affecting the BR and the angular distributions.

Accurate SM predictions can be obtained for some specific observables, like the Forward-Backward asymmetry (A_{FB}), the invariant $\mu\mu$ mass (q^2) value where A_{FB} reach its zero value (s_0), the transversal asymmetries and the ratio of BR for ee and $\mu\mu$ decay modes, where it is possible to obtain

As an example, for the $B \rightarrow K^* \ell \ell$ decay channel, the SM predictions (15) are: $BR(B_d \rightarrow K^* \mu\mu) = (1.22^{+0.38}_{-0.32}) 10^{-6}$ and zero crossing of A_{FB}

$$s_0 = s_0(C_7, C_9) = 4.39^{+0.38}_{-0.35} GeV^2 \quad (3)$$

In the LHCb experiment a selection yielding a B_{bb}/S of 0.2 ± 0.1 has been developed: 1.8 k events are expected in $0.5 fb^{-1}$, to be compared with the 450 events expected from the B factories with a $2 ab^{-1}$ integrated luminosity. With $2 fb^{-1}$ the sensitivity on s_0 is $0.46 GeV^2$, while with $10 fb^{-1}$ the present theoretical precision ($0.27 GeV^2$) is reached.

The ATLAS experiment expect ~ 3 k events with $30 fb^{-1}$, achieving a $\sim 4\%$ statistical error on the A_{FB} distribution in q^2 bins. The CMS studies have just started.

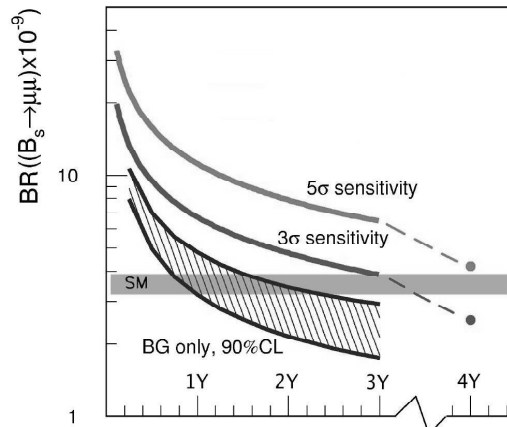


Figure 6 ATLAS perspective for measuring the $B_s^0 \rightarrow \mu^+ \mu^-$ branching ratio as a function of the time (integrated luminosity).

Table 5 Expected event yields and inclusive $b\bar{b}$ over signal events ratio for several B to D decays studied in LHCb.

Decay mode	Event yield	B_{bb}/S
$B^{-,+} \rightarrow D(K\pi)K^{-,+}$ favoured	28k	0.6
$B^{-,+} \rightarrow D(K\pi\pi\pi)K^{-,+}$ favoured	28k	0.6
$B^{-,+} \rightarrow D(K\pi)K^{-,+}$ supp.	100	>2
$B^{-,+} \rightarrow D(K\pi\pi\pi)K^{-,+}$ supp.	200	>2
$B^{-,+} \rightarrow D(hh)K^{-,+}$	4k	2
$B_s^{-,+} \rightarrow D_s K^{-,+}$	6.2k	0.2

Table 6 Expected precision on the CKM angle γ for several B to D decays studied in LHCb. The B and D decay modes and the analysis method are shown for each decay in the first three columns.

B Decay mode	D decay mode	Method	$\sigma(\gamma)$
$B_s \rightarrow D_s K$	$KK\pi$	tagged, A(t)	10°
$B^+ \rightarrow DK^+$	$K\pi+K3\pi+KK/\pi\pi$	counting, ADS, GLW	$5-13^\circ$
$B^+ \rightarrow D^*K^+$	$K\pi$	counting, ADS, GLW	Under study
$B^+ \rightarrow DK^+$	$K_s\pi\pi$	Dalitz, GGSZ	$7-12^\circ$
$B^+ \rightarrow DK^+$	$KK\pi\pi$	4 body Dalitz, GGSZ	18°
$B^+ \rightarrow DK^+$	$K\pi\pi\pi$	4 body Dalitz, GGSZ	Under study
$B^0 \rightarrow DK^{*0}$	$K\pi+KK+\pi\pi$	counting, ADS+GLW	9°

3.4 CKM γ angle

The measurement of the CKM angle γ through the analysis of hadronic decays, like $B \rightarrow DX$ or $B \rightarrow hh$, is only feasible and addressed so far in the LHCb experiment, the reason being the need of kaon and pion identification that is not available in ATLAS and CMS.

The selection of several decay modes has been studied in detail: the modes under study, together with their expected number of events (in 2 fb^{-1} integrated luminosity) and inclusive $b\bar{b}$ background over signal (B_{bb}/S) ratios are given in Table 5.

Several strategies can be pursued in order to measure γ . The analysis of $B \rightarrow DK$ channels, through the ADS or GLW and GGSZ approaches (16) uses the large statistics that can be collected at the cost of a dependence on the D strong phases affecting the sensitivity. The study of the less abundant $B_s \rightarrow D_s K$ decay mode yields instead a clean extraction of γ from the interference of $b \rightarrow u$ and $b \rightarrow c$ transitions in the B_s mixing. Other Dalitz and 4 body decay analyses can be pursued as well, yielding the expected resolutions quoted in Table 6

3.5 Cross section for $b\bar{b}$ production

The current prediction of $\sigma(b\bar{b}) \sim 500 \mu\text{b}$ comes from the extrapolations of Tevatron results: a precise measurement of such cross section is of major importance in order to test the MC simulations, the NLO QCD calculations used for the extrapolations and the Parton Density Functions (PDF) knowledge. For the rare decays, NP and new particle searches the knowledge of $\sigma(b\bar{b})$ is also important to achieve a good estimate of the background level.

Inclusive and exclusive strategies can be used to measure the cross section. All the LHC experiments plan to use J/Ψ events to measure the production rate: the muons in the decay ensure an high efficiency in triggering and reconstructing those channels. In ATLAS and CMS experiments an additional requirement on the transverse energy (E_T) is used in order to enhance the b quark component in the data sample.

The statistical error that can be achieved is $\sim 1\%$, already with small data samples ($L \sim O(10)pb^{-1}$). More detailed analyses, aiming at a full p_T scan, achieving a resolution of $\sim 10\%$ in all bins, have been performed in CMS assuming $L \sim 10 fb^{-1}$.

4 Conclusions

The LHC program is proceeding without major delays: first beam is expected in September and the first collisions soon afterwards. There are currently three experiments getting ready for the B physics challenge: with the expected performance they will be able to test SM and beyond SM (NP) effects.

The first analysis approach reported here is related to the $b \rightarrow s$ observables, that can cleanly reveal some NP effects. A first goal of the LHC experiments is the measurement of the $B_s \rightarrow \mu\mu$ BR down to its current SM prediction and of the ϕ_s angle with a 0.04 absolute precision. These goals can be achieved with data collected during 2009.

The analysis of $b \rightarrow sll$ decays is also presented: with few years of data taking the measurements precision will reach the level of present theoretical uncertainty.

The LHCb detector will also address the study of $B \rightarrow DK$ and $B \rightarrow hh$ decay modes that can be used to reduce the CKM γ angle uncertainty down to 10° , with data collected during 2009.

The measurement of $b\bar{b}$ production cross section within few %, with early data, and the full p_T scan (@ 10% level), with few years of data taking, can also be achieved.

The LHC experiments, whose B physics program highlights have been reported here, are ready to provide new measurements that will enrich the LHC program by exploring a new whole experimental region in the b quark phenomenology.

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