Radiative decays at LHCb

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1 Introduction

LHCb will seek to test the Standard Model of Particle Physics and confirm or constrain many of the new physics (NP) models by making precision measurements on the radiative decays of B-mesons. Radiative transitions in neutral B meson decays, such as $b \to s\gamma$ and $b \to d\gamma$, are very sensitive to NP, their properties being particularly sensitive to the presence of new heavy particles that may propagate virtually within the one-loop process involved in penguin diagrams. The polarization of emitted photons in radiative decays is particularly interesting as the $\overline{B}(B)$ meson decays predominantly into a left (right)-handed photon.

The branching ratio of the $B_d \to K^\star\gamma$ decay mode, measured first by CLEO then updated by Babar and Belle is precisely known, $\mathcal{B}(B_d) = (43.3 \pm 1.5) \times 10^{-6}$, thus, its measurement at LHCb will be crucial for the calorimeter calibration and can be used as control channel for other radiative decays. The penguin $B_s \to \phi\gamma$ decay has been observed by Belle, with a $\mathcal{B}(B_s \to \phi\gamma) = 57^{+22}_{-19} \times 10^{-6}$.

2 LHCb Detector

LHCb is a single-arm spectrometer composed of Vertex Locator, Tracking System, RICH detectors, Calorimeter System (Preshower, ECAL, HCAL) and Muon system to explore the strongly forward peaked $b\bar{b}$ production at the LHC.

LHCb is designed to analyse CP violation and rare decays of B-mesons and b-baryons, to improve the Standard Model determinations on CKM parameters and to explore the full potential of physics beyond the Standard Model.

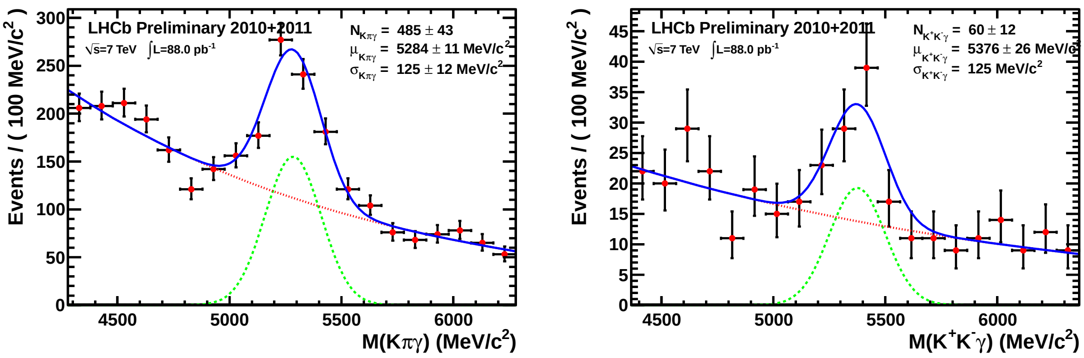
Calorimeter calibration is one of the important prerequisites regarding radiative decays studies. Full calibration of the ECAL involves several steps. A 9% relative cell-to-cell intercalibration is reached through a monitoring system installed in the calorimeter. For further improvement, using the energy flow method, the ECAL is precalibrated down to 5% and finally, with the π^0 calibration method the intercalibration of the cells to less than 2% level is achieved.

3 $B_d \rightarrow K^\star\gamma$ and $B_s \rightarrow \phi\gamma$ Mass Peaks

As the kinematic description of $B_d \rightarrow K^\star\gamma$ and $B_s \rightarrow \phi\gamma$ decays is very similar, a common selection is performed. Pions and kaons are identified using the LHCb hadron identification system. A vertex fit on such selected tracks is applied to form $K^\star(\phi)$ candidates. A $K^\star(\phi)$ candidate is then combined with a high energy photon, ($E_T > 2.5\ GeV$). The primary vertex with minimum B impact parameter is chosen as B production vertex.

Combinatorial background is suppressed by constraining the angle between the B momentum vector and B flight direction (distance between production and decay vertex). $K^\star(\phi)$ are produced with different polarizations for signal and background, this property is exploited to suppress correlated background from decays with π^0 in final states. Significant reduction of the background level is accomplished through additional cuts (B transverse momentum, track multiplicity)

With 88 pb^{-1} of integrated luminosity we collected (485 ± 43) $B_d \rightarrow K^\star\gamma$ candidates, as seen in Figure 1a, and (60 ± 12) $B_s \rightarrow \phi\gamma$ candidates, Figure 1b.



(a) (b)

Figure 1: (a) $B_d \rightarrow K^\star\gamma$ invariant mass peak, (b) $B_s \rightarrow \phi\gamma$ invariant mass peak.

4 Conclusions

With $\sim 37\ pb^{-1}$ of recorded data in 2010 and $\sim 50\ pb^{-1}$ in 2011, LHCb performance is close to expectation; with limited statistics from 2010 data, the calorimeter has been calibrated to a level of 2%.

It is expected that already this summer, the accumulated statistics of these decays will be similar to B-factories for $B_d \rightarrow K^\star\gamma$ and a unique sample of ~ 200 $B_s \rightarrow \phi\gamma$ that will allow a precise determination of the Branching ratio for these decays.

By the end of 2011, with a luminosity of $\sim 1\ fb^{-1}$, LHCb will be able to produce improved measurements of the direct CP asymmetry and expand the accessible range for raditive decays.