$B_s^0 \to \mu^+\mu^-\gamma$ decay at LHCb

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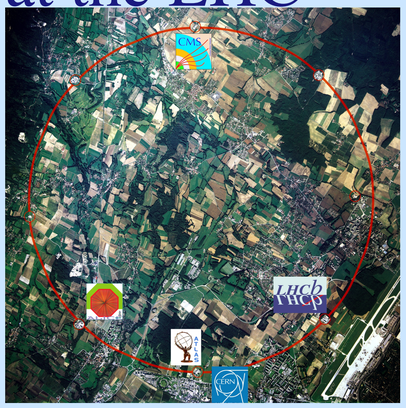
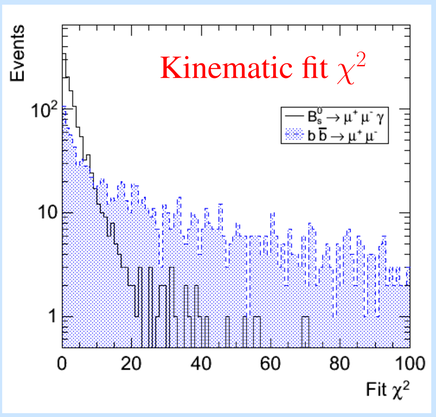
B production at the LHC



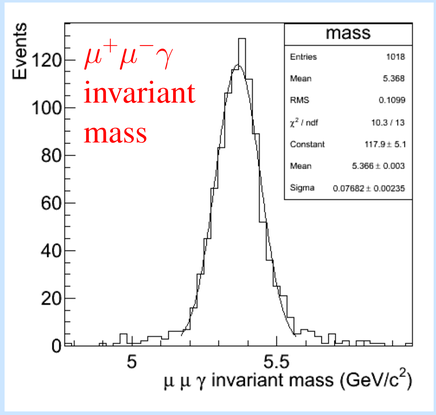
The Large Hadron Collider will provide proton-proton collisions at $\sqrt{s} = 14\ TeV$, in these conditions pairs of $b\bar{b}$ quarks are produced correlated and peaked at polar angles $\theta_b = 0,\pi$,
with a cross-section of order $500\ \mu b$;
considering the LHCb acceptance this gives an effective cross-section of $230\ \mu b$.
With a nominal luminosity
$\mathcal{L} = 2 \cdot 10^{32} cm^{-2} s^{-1}$,
in one year ($10^7\ s$) of data taking, $2\ fb^{-1}$ of integrated luminosity will be collected, that correspond to $10^{12}\ b\bar{b}$ pairs.



Introduction

In the search for new physics a leading role is played by Flavour Changing Neutral Currents mediated processes: being highly suppressed in the Standard Model due to the GIM mechanism, and occurring just at the loop and box level, they can receive contributions from new particles and in general be enhanced due to new physics models. Among them very clear signals can come from $B_s^0 \to \mu^+\mu^-$ and $B_s^0 \to \mu^+\mu^-\gamma$ which will be studied at the LHCb experiment. Both these decays occurr with a branching ratio in the SM at the level of 10^{-8}: the $B_s^0 \to \mu^+\mu^-\gamma$ in fact is suppressed by having one more vertex but enhanced by removing the elicity suppression of the $B_s^0 \to \mu^+\mu^-$ decay.

Selection



Trigger: The LHCb Muon trigger is well suited for this channel and has been found to have an efficiency of 94% on signal events.

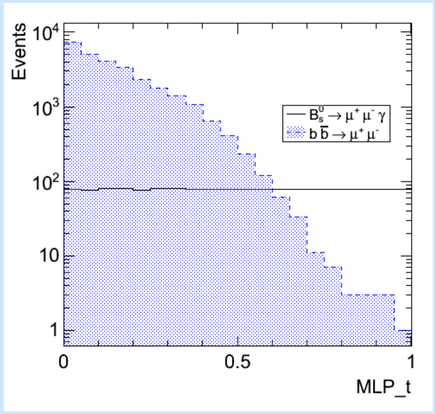
Preselection: A first reduction of the background (mainly from $b\bar{b} \to \mu^+\mu^-$ events) will be achieved through cuts on following variables: muon transverse momentum, photon transverse momentum, pointing angle, B vertex χ^2, impact parameter significance of the B with respect to Primary Vertex, identification variable for the photon.

Kinematic Fit: An hit in the calorimeter is associated to the di-muon vertex and a kinematic fit is applied: a cut on the χ^2 of this fit selects the best candidates in order to reduce the background from spurious photons.

Final selection: multivariate methods

Different variables have been combined in multivariate methods in order to distinguish signal from background. The method output variable has been used to estrac the limit which LHCb will be able to put on the $B_s^0 \to \mu^+\mu^-\gamma$ branching ratio.

Multivariate method output

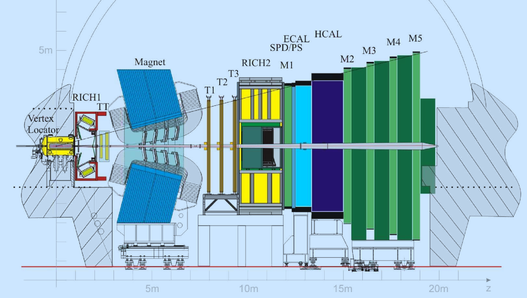


Results: LHCb (in case of no signal observation) will be able to put the following limit
BR($B_s^0 \to \mu^+\mu^-\gamma$)$< (1.02^{+0.399}_{-0.256}) \cdot 10^{-7}$ in 22.3 pb^{-1} of integrated luminosity and a limit of
BR($B_s^0 \to \mu^+\mu^-\gamma$)$< (1.07^{+0.421}_{-0.27}) \cdot 10^{-8}$ in 2 fb^{-1} of integrated luminosity.

a *beauty*ful experiment

Dedicated for the study of *b* hadrons, LHCb will exploit the copious production of *beauty* mesons and baryons in proton-proton collisions at the LHC. Precision measurements of CP violation and rare decays will be performed and the heavy flavour sector will be studied in detail searching for New Physics.

LHCb detector layout



LHCb detector

VErtex LOcator: silicon detector, optimum vertex resolution ($\sim 50\ \mu$m)
TT, T1-T3: tracking stations; momentum resolution $\sigma(p)/p \sim 0.4\%$.
ECAl / HCAL, electromagnetic ($\sigma_E/E \simeq 9\%/\sqrt{E} \oplus 0.8\%$) and hadronic calorimeters ($\sigma_E/E \simeq 69\%/\sqrt{E} \oplus 9\%$)
RICH: Ring Imaging Cherenkov detectors for particle identification ($\varepsilon(K) \sim 95\%$ at 5% of π/K mis-id).
M1-M5: muon stations ($\varepsilon(\mu) \sim 94\%$ at 3% of $\pi, K/\mu$ mis-id).