

Search for $B_s \rightarrow \mu\mu$ and $B_d \rightarrow \mu\mu$
at the CMS experiment

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January 30, 2012

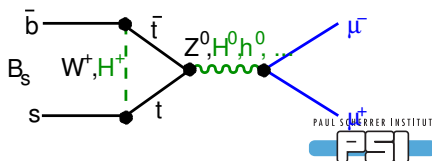
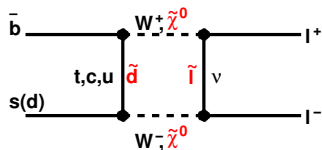
Introduction

- ▶ Decay is highly suppressed in SM.
 - ▶ effective FCNC, helicity suppressed.
 - ▶ SM expectation

$$\mathcal{B}(B_s \rightarrow \mu\mu) = (3.2 \pm 0.2) \times 10^{-9}$$

$$\mathcal{B}(B_d \rightarrow \mu\mu) = (1.0 \pm 0.1) \times 10^{-10}$$

- ▶ CMS can constrain BSM **directly** and **indirectly**
 - ▶ MSSM: $\mathcal{B} \propto (\tan \beta)^6$
 - ▶ Cabibbo-enhancement ($|V_{ts}| > |V_{td}|$) of $B_s \rightarrow \mu\mu$ over $B_d \rightarrow \mu\mu$ only in MFV models.
 - ▶ \mathcal{B} could also be smaller than SM prediction.
- Constraints on parameter region
- Sensitivity to extended Higgs boson sectors



Analysis overview

► Signal signature

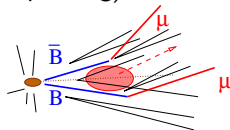
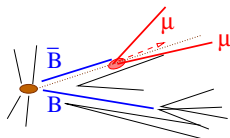
- two muons from one decay vertex
- dimuon mass around
 $m_{B_s} = (5.3663 \pm 0.0006) \text{ GeV}$

► Background composition

- two independent semileptonic B decays
- one semileptonic (B) decay and one misidentified hadron
- rare single B decays (peaking and non-peaking)

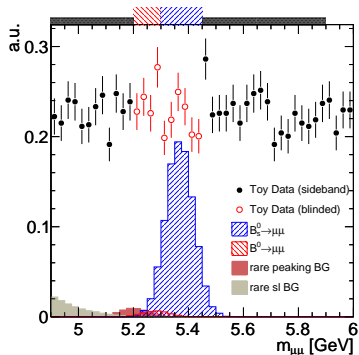
► Most powerful variables

- Isolation of B candidate
- good vertex fit
- small pointing angle
- high flight length significance ℓ_{3D}/σ_{3D}
- distance of closest approach of nearest track to SV



Event selection

- ▶ Vertexing pairs of muons and fill in histogram
- ▶ **Blind analysis:** Everything of the analysis was set **before** looking at the number of entries in the signal region.
 - ⇒ No signal candidates were reconstructed in the mass range $5.2\text{GeV} < m_{\mu\mu} < 5.45\text{GeV}$
 - ▶ Avoid bias
 - ▶ Avoid overtuning
 - ▶ Tradition in field
- ▶ Sideband was used to study the background in data.



Results

- ▶ Measurement of an upper limit on branching fraction with $\mathcal{L}_{\text{int}} = 1.14/\text{pb}^1$

$$\mathcal{B}(B_s \rightarrow \mu\mu) \leq 1.9 \cdot 10^{-8}$$

$$\mathcal{B}(B_d \rightarrow \mu\mu) \leq 4.6 \cdot 10^{-9}$$

- ▶ Recall SM expectations

$$\mathcal{B}(B_s \rightarrow \mu\mu) = (3.2 \pm 0.2) \cdot 10^{-9}$$

$$\mathcal{B}(B_d \rightarrow \mu\mu) = (1.0 \pm 0.1) \cdot 10^{-10}$$

- ▶ LHCb limits (EPS 11)

$$\mathcal{B}(B_s \rightarrow \mu\mu) \leq 1.5 \cdot 10^{-8}$$

$$\mathcal{B}(B_d \rightarrow \mu\mu) \leq 5.2 \cdot 10^{-9}$$

¹Phys. Rev. Lett. 107, 191802 (2011)

Personal contribution

- ▶ For EPS 11 result
 - ▶ framework to reconstruct candidates.
 - ▶ (Almost) All steps in the analysis were done twice to cross check results. One of this analysis chains was written by me.
 - ▶ upper limit calculation based on RooStats
- ▶ EPS 11 up to end of year
 - ▶ No $B_s \rightarrow \mu\mu$ related stuff
 - ▶ Analog integrated circuit design for CMS Phase 1 upgrade (2013 / 2014?)
 - ▶ Startup circuit for DAC registers in pixel readout chip.
 - ▶ Digital Level Translator Chip to drive LLV with new voltages
- ▶ Since 2012
 - ▶ upper limit calculation based on RooStats

Thank you for your attention