PROCEEDINGS OF SCIENCE

Search for Bs,B0->mumu decays at CMS

Arno Heister, on behalf of the CMS Collaboration*
RWTH Aachen
E-mail: Arno.Heister@cern.ch

Results were presented from a search for the rare decays $B_s \to \mu^+\mu^-$ and $B^0 \to \mu^+\mu^-$ in pp collisions at $\sqrt{s}$ = 7 and 8 TeV, with data samples corresponding to integrated luminosities of 5 and 20 fb^{-1}, respectively, collected by the CMS experiment at the LHC. An unbinned maximum-likelihood fit to the dimuon invariant mass distribution gives a branching fraction $\mathscr{B}(B_s \to \mu^+\mu^-) = (3.0^{+1.0}_{-0.9}) \times 10^{-9}$, where the uncertainty includes both statistical and systematic contributions. An excess of $B_s \to \mu^+\mu^-$ events with respect to background is observed with a significance of 4.3 standard deviations. The expected median significance of this excess is 4.8 standard deviations. For the decay $B^0 \to \mu^+\mu^-$ an upper limit of $\mathscr{B}(B^0 \to \mu^+\mu^-) < 1.1 \times 10^{-9}$ at the 95% confidence level is determined. Both results are in agreement with the expectations from the standard model.

The 15th International Conference on B-Physics at Frontier Machines at the University of Edinburgh
14 -18 July, 2014
University of Edinburgh, UK

*Speaker.

PoS(Beauty2014)048

In the standard model (SM) of particle physics, tree-level diagrams do not contribute to flavor-changing neutral-current (FCNC) decays. However, FCNC decays may proceed through higher-order loop diagrams, and this opens up the possibility for contributions from non-SM particles. In the SM, the rare FCNC decays $B_s(B^0) \to \mu^+\mu^-$ have small branching fractions of $\mathscr{B}(B_s \to \mu^+\mu^-) = (3.57 \pm 0.30) \times 10^{-9}$, corresponding to the decay-time integrated branching fraction, and $\mathscr{B}(B^0 \to \mu^+\mu^-) = (1.07 \pm 0.10) \times 10^{-10}$ [1, 2].

Several extensions of the SM, such as supersymmetric models with non-universal Higgs boson masses [3], specific models containing leptoquarks [4], and the minimal supersymmetric standard model with large $\tan\beta$ [5, 6], predict enhancements to the branching fractions for these rare decays. The decay rates can also be suppressed for specific choices of model parameters [7].

Over the past 30 years, significant progress in sensitivity has been made, with exclusion limits on the branching fractions improving by five orders of magnitude. The ARGUS [8], UA1 [9], CLEO [10], Belle [11], BaBar [12], CDF [13], D0 [14], ATLAS [15], CMS [17], and LHCb [16] experiments have all published limits on these decays (see Figure 1). The LHCb experiment has subsequently shown evidence, with 3.5 standard deviation significance, for the decay $B_s \to \mu^+\mu^-$ with $\mathscr{B}(B_s \to \mu^+\mu^-) = (3.2^{+1.5}_{-1.2}) \times 10^{-9}$ [18].

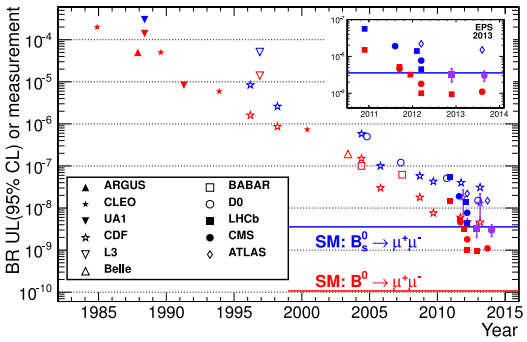

Figure 1: Historical perspective of the search for $B \to l + l-$. The inset shows the recent past. [19]

In the presentation a measurement of $\mathscr{B}(B_s \to \mu^+\mu^-)$ based on a simultaneous search for $B_s \to \mu^+\mu^-$ and $B^0 \to \mu^+\mu^-$ decays using a data sample of pp collisions corresponding to integrated luminosities of $5\,fb^{-1}$ at $\sqrt{s} = 7$ TeV and $20\,fb^1$ at 8 TeV collected by the Compact Muon Solenoid (CMS) experiment at the Large Hadron Collider (LHC) was reported [20]. For these data, the peak luminosity varied from 3.5×10^{30} to $7.7 \times 10^{33}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$. The average number of interactions per bunch crossing (pileup) was 9 (21) at $\sqrt{s} = 7(8)$ TeV. The search for the $B \to \mu^+\mu^-$ signal, where B denotes B_s or B_0, is performed in the dimuon invariant mass regions around the B_s and B^0 masses.

Figure 2 shows the result of the search for the rare decays $B_s \to \mu^+\mu^-$ and $B^0 \to \mu^+\mu^-$. No significant evidence is observed for $B^0 \to \mu^+\mu^-$ and an upper limit of $\mathscr{B}(B^0 \to \mu^+\mu^-) < 1.1 \times 10^{-9}$ is established at 95% CL. For $B_s \to \mu^+\mu^-$, an excess of events with a significance of 4.3 (4.8) standard deviations is observed (median expected), and a branching fraction of $\mathscr{B}(B_s \to \mu^+\mu^-) = (3.0^{+1.0}_{-0.9}) \times 10^{-9}$ is determined, in agreement with the standard model expectations.

The CMS experiment prepares for improved measurements of these rare B decays for the upcoming LHC run 2 starting 2015. The LHC experiments' objective for 2015 is to run a physics

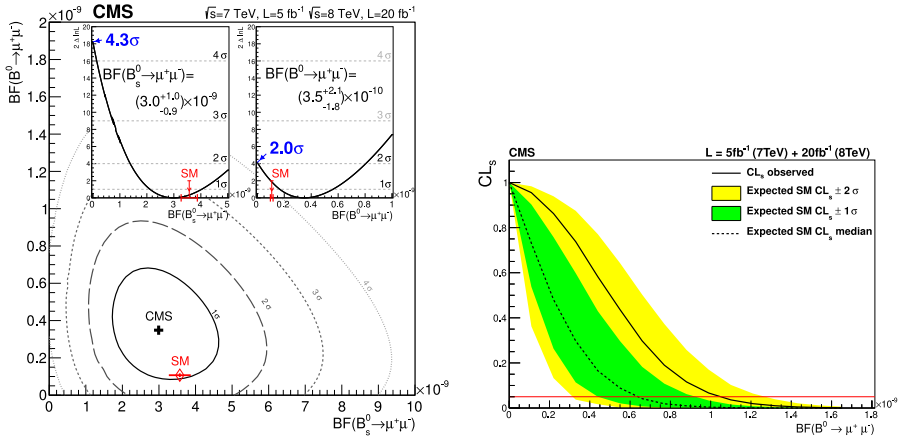

Figure 2: Left, scan of the ratio of the joint likelihood for $\mathscr{B}(B_s \to \mu^+\mu^-)$ and $\mathscr{B}(B^0 \to \mu^+\mu^-)$. As insets, the likelihood ratio scan for each of the branching fractions when the other is profiled together with other nuisance parameters; the significance at which the background-only hypothesis is rejected is also shown. Right, observed and expected $\mathrm{CL_S}$ for $B^0 \to \mu^+\mu^-$ as a function of the assumed branching fraction. [20]

programme at $\sqrt{s} = 13$ TeV, which will result in *e.g.* much higher pileup per event ($\simeq 40$) compared to run 1. For the CMS experiment the triggering on the rare $B_s(B^0)$ decays to μ^+, μ^- final states will be a major challenge then.

References

[1] A. J. Buras, arXiv:1009.1303 [hep-ph].

[2] K. De Bruyn, R. Fleischer, R. Knegjens, P. Koppenburg, M. Merk, A. Pellegrino and N. Tuning, Phys. Rev. Lett. **109** (2012) 041801 [arXiv:1204.1737 [hep-ph]].

[3] J. R. Ellis, K. A. Olive, Y. Santoso and V. C. Spanos, JHEP **0605** (2006) 063 [hep-ph/0603136].

[4] S. Davidson and S. Descotes-Genon, JHEP **1011** (2010) 073 [arXiv:1009.1998 [hep-ph]].

[5] S. R. Choudhury, A. S. Cornell, N. Gaur and G. C. Joshi, Int. J. Mod. Phys. A **21** (2006) 2617 [hep-ph/0504193].

[6] J. K. Parry, Nucl. Phys. B **760** (2007) 38 [hep-ph/0510305].

[7] J. R. Ellis, J. S. Lee and A. Pilaftsis, Phys. Rev. D **76** (2007) 115011 [arXiv:0708.2079 [hep-ph]].

[8] H. Albrecht *et al.* [ARGUS Collaboration], Phys. Lett. B **199** (1987) 451.

[9] C. Albajar *et al.* [UA1 Collaboration] Phys. Lett. B **262** (1991) 163.

[10] T. Bergfeld *et al.* [CLEO Collaboration], Phys. Rev. D **62** (2000) 091102 [hep-ex/0007042].

[11] M. C. Chang *et al.* [BELLE Collaboration], Phys. Rev. D **68** (2003) 111101 [hep-ex/0309069].

[12] B. Aubert *et al.* [BaBar Collaboration], Phys. Rev. D **77** (2008) 032007 [arXiv:0712.1516 [hep-ex]].

[13] T. Aaltonen *et al.* [CDF Collaboration], Phys. Rev. D **87** (2013) 072003 [arXiv:1301.7048 [hep-ex]].

[14] V. M. Abazov *et al.* [D0 Collaboration], Phys. Rev. D **87** (2013) 7, 072006 [arXiv:1301.4507 [hep-ex]].

[15] G. Aad *et al.* [ATLAS Collaboration], Phys. Lett. B **713** (2012) 387 [arXiv:1204.0735 [hep-ex]].

[16] R. Aaij *et al.* [LHCb Collaboration], Phys. Lett. B **699** (2011) 330 [arXiv:1103.2465 [hep-ex]].

[17] S. Chatrchyan *et al.* [CMS Collaboration], JHEP **1204** (2012) 033 [arXiv:1203.3976 [hep-ex]].

[18] R. Aaij *et al.* [LHCb Collaboration], Phys. Rev. Lett. **110** (2013) 021801 [arXiv:1211.2674 [hep-ex]].

[19] https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsBPH13004

[20] S. Chatrchyan *et al.* [CMS Collaboration], Phys. Rev. Lett. **111** (2013) 101804 [arXiv:1307.5025 [hep-ex]].