The study of the rare decays $B^0_{(s)} \to \mu^+\mu^-$ at $\sqrt{s}$ = 13 TeV with the ATLAS detector

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on behalf of the ATLAS Collaboration

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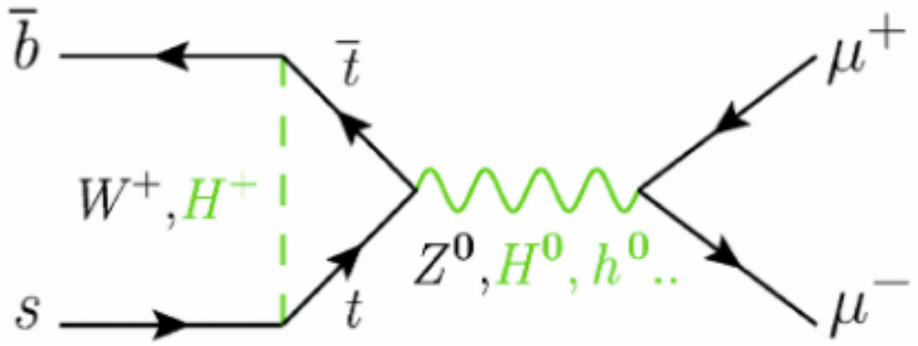
ErUM-FSP T02 ATLAS

Introduction

The rare decays $B^0_s \to \mu^+\mu^-$ are flavour changing neutral current processes

- Strongly suppressed
- Branching ratios predicted by the SM
  - $B(B^0_s \to \mu^+\mu^-) = (3.66 \pm 0.14) \times 10^{-9}$
  - $B(B^0 \to \mu^+\mu^-) = (1.03 \pm 0.05) \times 10^{-10}$

[JHEP 10 (2019) 232]



- Deviations from prediction may indicate new physics that involves non-SM heavy particles

The branching fractions are measured relative to the reference decay mode $B^\pm \to J/\psi\,(\to \mu^+\mu^-)K^\pm$

$$\mathcal{B}(B^0_{(s)} \to \mu^+\mu^-) = N_{d(s)} \frac{\mathcal{B}(B^+ \to J/\psi\, K^+) \times \mathcal{B}(J/\psi \to \mu^+\mu^-)}{N_{J/\psi K^+} \times (\varepsilon_{\mu^+\mu^-}/\varepsilon_{J/\psi K^+})} \times \frac{f_u}{f_{d(s)}}$$

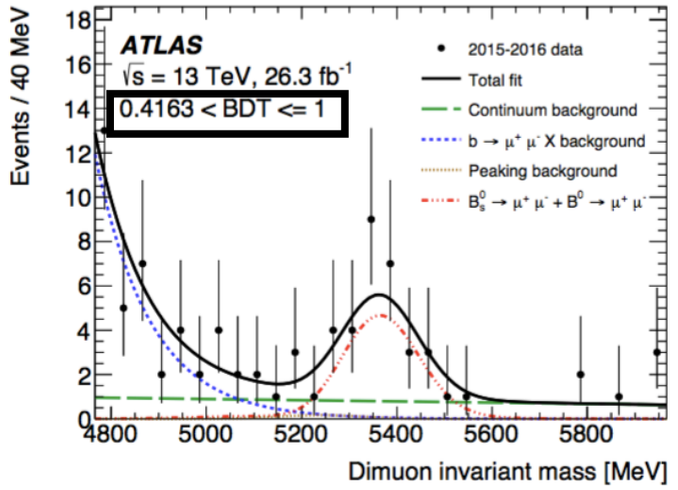
- Blind analysis is performed
  - blinded dimuon invariant mass region [5166, 5526] MeV
  - unbiased background rejection
- Continuum background is dominant: muons from uncorrelated hadron decays
- Boosted Decision Tree (BDT) to reject the continuum background is trained on sideband data

Analysis

Signal yield is extracted with unbinned maximum-likelihood fit to $m_{\mu\mu}$ simultaneously across four intervals of BDT

- each BDT interval has equal signal efficiency of 18%

Extracted (expected) yields: N_s = 80 ± 22 (91), N_d = -12 ± 20 (10)



world averages, PDG: $(1.010 \pm 0.029) \times 10^{-3} \times (5.961 \pm 0.033) \times 10^{-2}$ [Phys. Rev. D 98 (2018) 030001]

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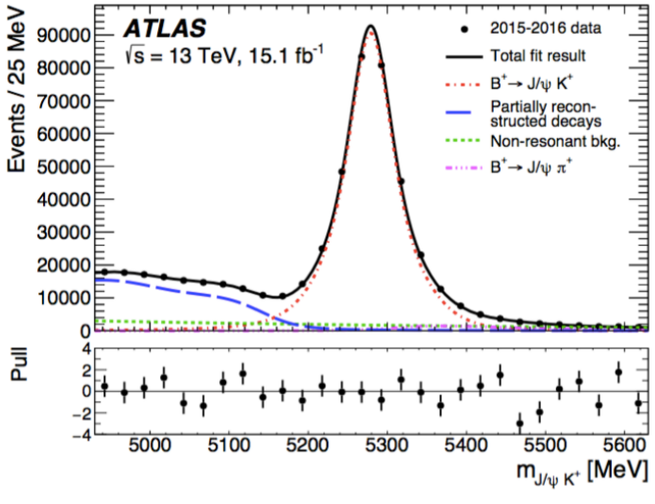


Reference channel yield from unbinned extended maximum-likelihood fit to $m_{J/\psi K}$

$B^{\pm}$ yield = 33435
± 0.3% (stat)
± 4.8% (sys)

Estimated from MC

- in fiducial region with $p_T(B) > 8$ GeV and $|\eta_B| < 2.5$
- checked and corrected for data-mc differences

$\varepsilon_{J/\psi K}/\varepsilon_{\mu\mu}$ = 0.1176
± 0.0009 (stat)
± 0.0047 (sys)

$f_{d(s)}$

HFLAV average: the ratio of the hadronisation prob. of a *b*-quark into B^+ and $B^0_{(s)}$

$f_s/f_d = 0.256 \pm 0.013$;

$f_u/f_d = 1$

[Eur. Phys. J. C 77 (2017) 895]

Results

Branching fractions using 2015 + 2016 data

$$\mathcal{B}(B_s^0 \to \mu^+\mu^-) = \left(3.21^{+0.96+0.49}_{-0.91-0.30}\right) \times 10^{-9}$$

$$\mathcal{B}(B^0 \to \mu^+\mu^-) < 4.3 \times 10^{-10} \quad @\ 95\%\ \text{CL}$$

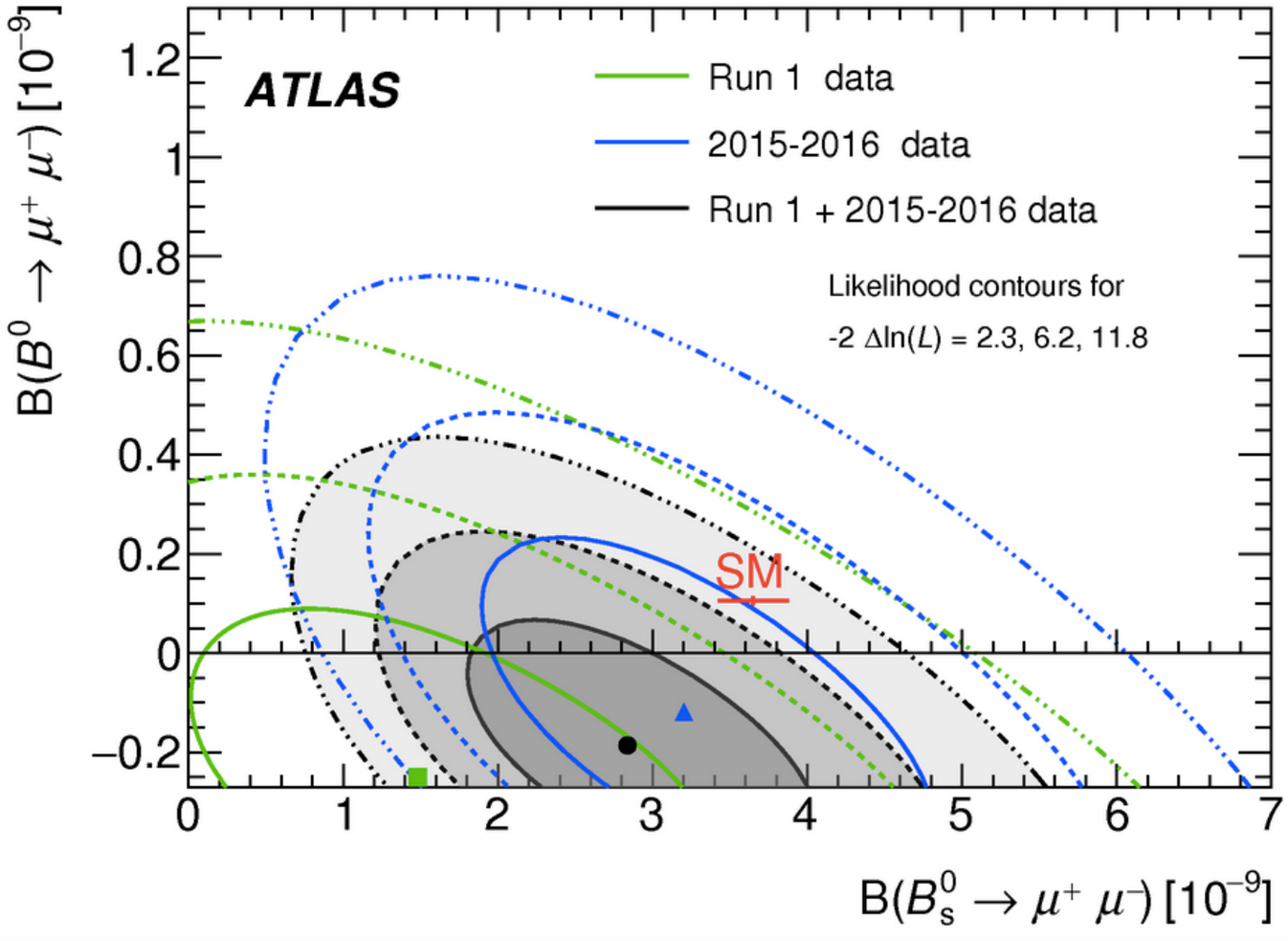
Combination with Run1

$$\mathcal{B}(B_s^0 \to \mu^+\mu^-) = \left(2.8^{+0.8}_{-0.7}\right) \times 10^{-9}$$

$$\mathcal{B}(B^0 \to \mu^+\mu^-) < 2.1 \times 10^{-10}$$

@ 95% CL

Combined measurement is compatible with SM at 2.4 σ



[JHEP 04 (2019) 098]