Supplementary material to LHCb-PAPER-2019-009

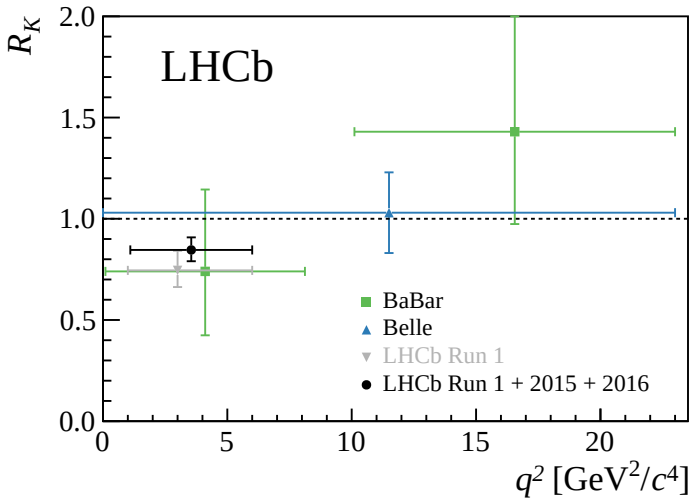

Figure 1: Comparison of the LHCb R_K measurements with previous experimental results from LHCb [1] and the B factories [2, 3]. The LHCb Run 1 result is greyed out since it is superseded by the new result.

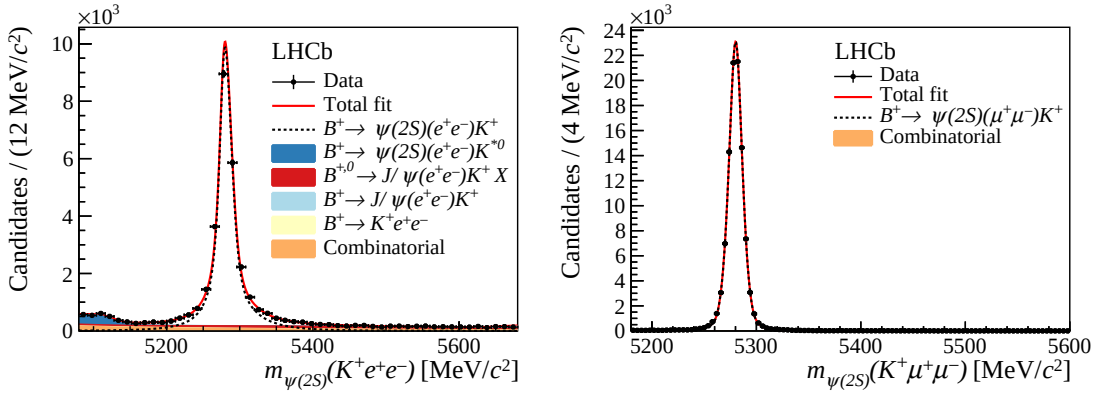

Figure 2: Fits to the $m_{\psi(2S)}(K^+\ell^+\ell^-)$ invariant-mass distribution of (left) $B^+ \to \psi(2S)(\to e^+e^-)K^+$ and (right) $B^+ \to \psi(2S)(\to \mu^+\mu^-)K^+$ candidates. Electron (muon) candidates are required to have $9.92 < q^2 < 16.40\,\text{GeV}^2/c^4$ ($12.5 < q^2 < 14.2\,\text{GeV}^2/c^4$).

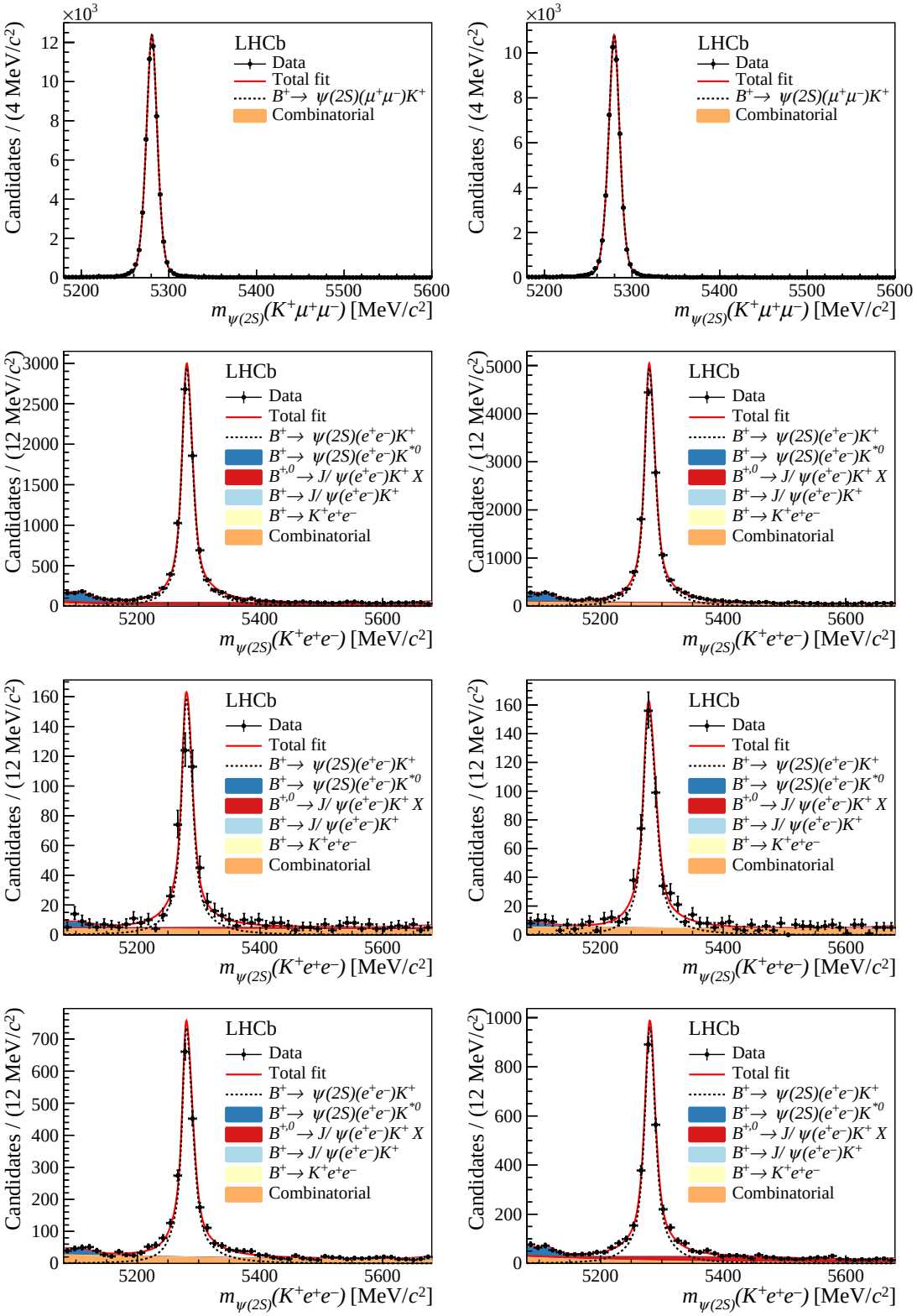

Figure 3: Fit to the $m_{\psi(2S)}(K^+\ell^+\ell^-)$ invariant mass distribution of $B^+ \to \psi(2S)(\to \ell^+\ell^-)K^+$ candidates in the (left) 7 and 8 TeV and (right) 13 TeV data samples. Electron (muon) candidates are required to have $9.92 < q^2 < 16.40\,\text{GeV}^2/c^4$ ($12.5 < q^2 < 14.2\,\text{GeV}^2/c^4$). The top row shows the fit to the muon modes and the subsequent rows the fits to the electron modes triggered by (second row) one of the electrons, (third row) the kaon and (last row) by other particles in the event.

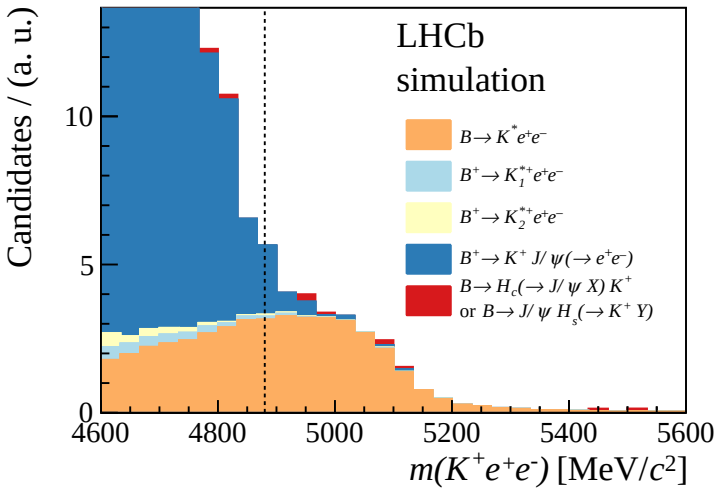

Figure 4: Invariant mass distribution for partially reconstructed backgrounds to the $B^+ \to K^+e^+e^-$ decay and leakage from $B^+ \to J/\psi(\to e^+e^-)K^+$ obtained from simulation. The lower edge of the $m(K^+\ell^+\ell^-)$ range in which the nonresonant mode is selected is shown with a dotted black line. The relative branching fraction of $B^{0,+} \to K^*(892)^{(0,+)}(\to K^+\pi^{(-,0)})e^+e^-$ decays and decays containing $K^{*+}_{1,2}$ mesons is assumed to be equal to that observed in the equivalent resonant modes [4].

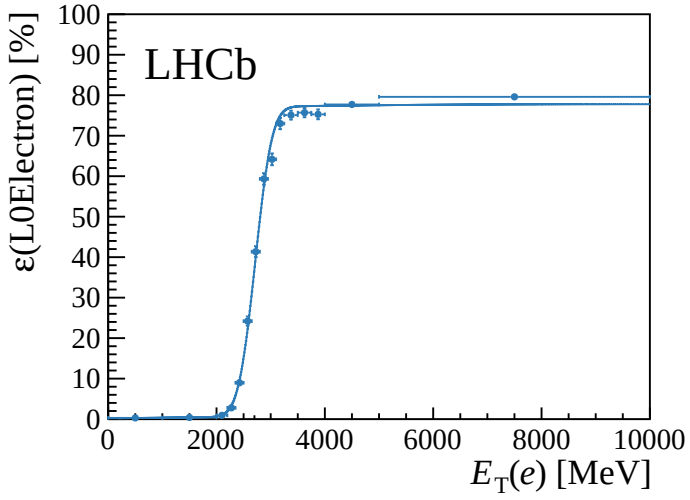

Figure 5: Efficiency of the `L0Electron` line as a function of the transverse energy of the electron candidate measured using $B^+ \to J/\psi(\to e^+e^-)K^+$ decays, in the intermediate ECAL regions and in for candidates recorded during 2016. A fit to the data points is shown with a solid line.

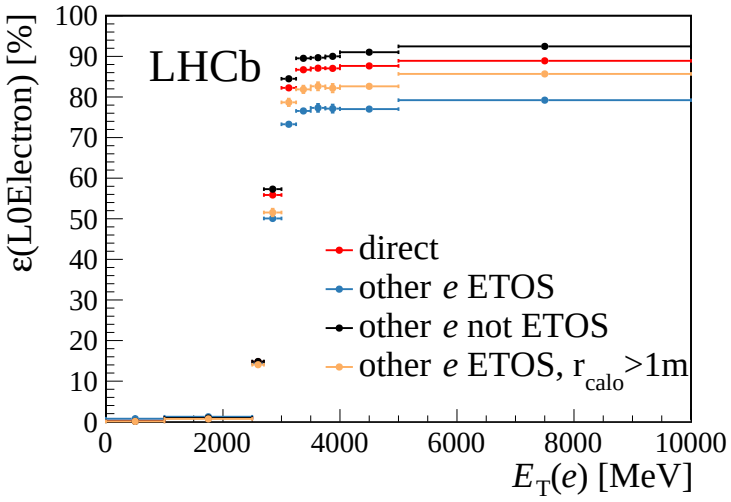

Figure 6: Efficiency of the `L0Electron` line as a function of the transverse energy of one of the two electron candidates (probe) for $B^+ \to J/\psi(\to e^+e^-)K^+$ simulated events, in the inner-most ECAL regions and for the Run 2 data taking conditions. The efficiency is shown in the case where no requirement is placed on the other electron (red), when the other electron is required to have fired the `L0Electron` trigger (blue), when the other electron is required not to have fired the `L0Electron` trigger (black) and when the other electron has fired but is more than 1m away from the probe electron (orange).

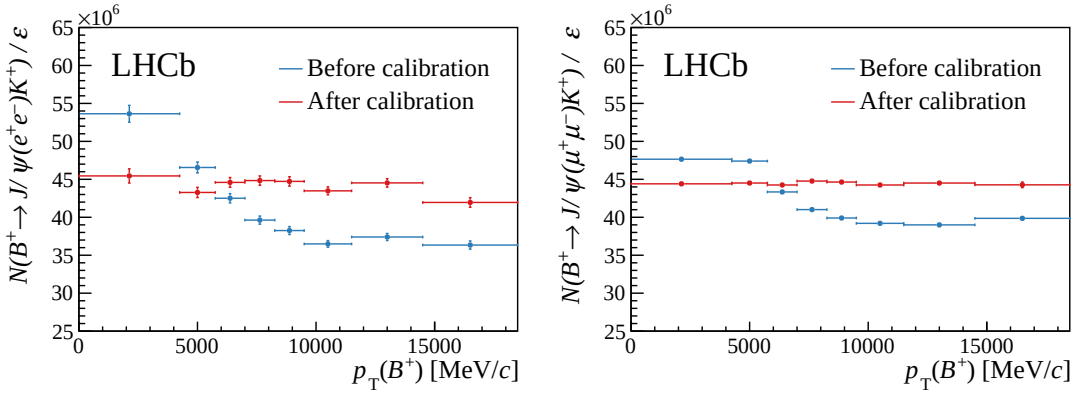

Figure 7: Efficiency corrected (left) $B^+ \to J/\psi(\to e^+e^-)K^+$ and (right) $B^+ \to J/\psi(\to \mu^+\mu^-)K^+$ yields in the Run 1 sample as a function of the B^+ transverse momentum. The values are shown both before and after the calibration of the simulation used to determine the efficiencies.

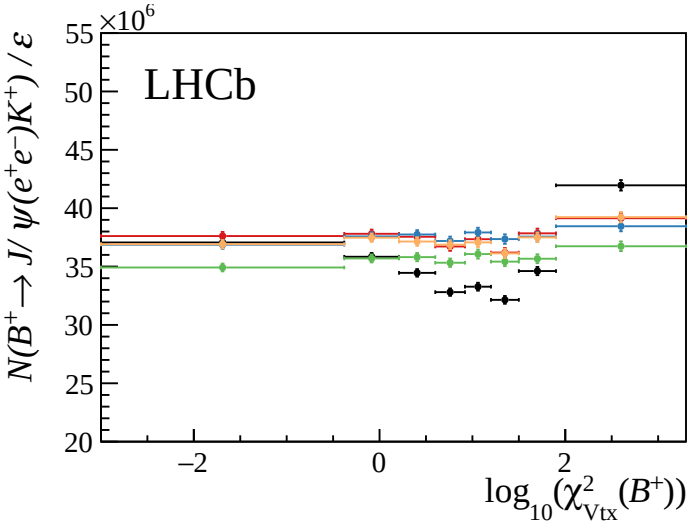

Figure 8: Efficiency corrected $B^+ \to J/\psi(\to e^+e^-)K^+$ yield in the Run 2 sample as a function of the χ^2 of the B^+ vertex fit. The different sets of points correspond to different efficiency computations using either (black) no kinematic weights or weights derived from the $B^+ \to J/\psi(\to \mu^+\mu^-)K^+$ (red) `L0MuonTOS` or (green) `L0MuonTIS` samples, or the $B^+ \to J/\psi(\to e^+e^-)K^+$ (blue) `L0ElectronTOS` sample. The orange set of points corresponds to kinematic weights computed with both the $B^+ \to J/\psi(\to \mu^+\mu^-)K^+$ and $B^+ \to J/\psi(\to e^+e^-)K^+$ samples.

References

[1] LHCb collaboration, R. Aaij *et al.*, *Test of lepton universality using $B^+ \to K^+\ell^+\ell^-$ decays*, Phys. Rev. Lett. **113** (2014) 151601, arXiv:1406.6482.

[2] BaBar collaboration, J. P. Lees *et al.*, *Measurement of branching fractions and rate asymmetries in the rare decays $B \to K^{(*)}\ell^+\ell^-$*, Phys. Rev. D **86** (2012) 032012.

[3] Belle collaboration, J.-T. Wei *et al.*, *Measurement of the differential branching fraction and forward-backward asymmetry for $B \to K^{(*)}\ell^+\ell^-$*, Phys. Rev. Lett. **103** (2009) 171801, arXiv:0904.0770.

[4] Particle Data Group, M. Tanabashi *et al.*, *Review of particle physics*, Phys. Rev. **D98** (2018) 030001.