Supplementary Material for LHCb-PAPER-2018-046

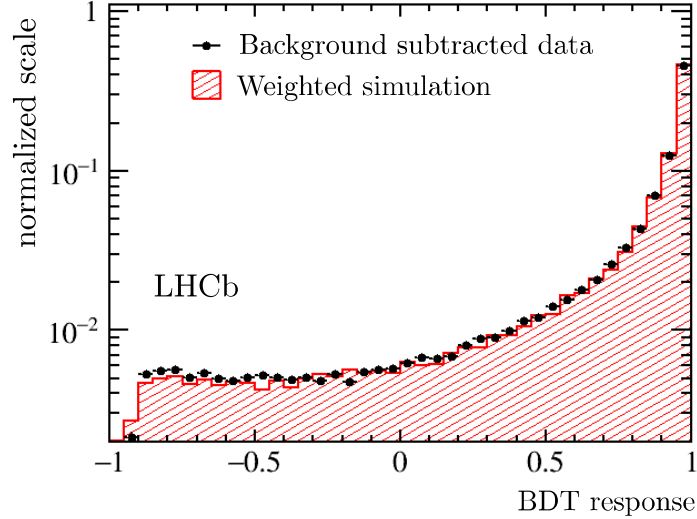## Validation of the $\mathrm{BDT_{CS}}$ classifier including hadron PID variables

Figure 1: Distributions of the $\mathrm{BDT_{CS}}$ classifier response for the $B_s^0 \to J/\psi\,\phi$ control mode for data and simulated events.

The use of hadron PID variables in a BDT is validated using the control mode. A single BDT is used in this case, where the training is performed including both the kinematic variables and PID information. Figure 1 shows the comparison of the single $\mathrm{BDT_{CS}}$ for the control mode selection, which is trained on both PID and kinematic variables. The distribution of the classifier response is found to be in excellent agreement between the weighted simulation and background-subtracted data.

Fit result for $B_s^0 \to J/\psi\phi$ control mode

The fit to the $J/\psi\,K^+K^-$ invariant-mass distribution for the control mode is shown in Fig. 2.

World average for the B^0 mass

Figure 3 shows the combination of the B^0 mass where the LHCb average includes the present measurement along with a previous result employing a data sample corresponding to $35\,\mathrm{pb}^{-1}$ of integrated luminosity collected in 2010. Only the systematic uncertainty corresponding to the energy loss of the protons in the detector material is assumed to be correlated among the two measurements, since the calibrations correspond to independent datasets.
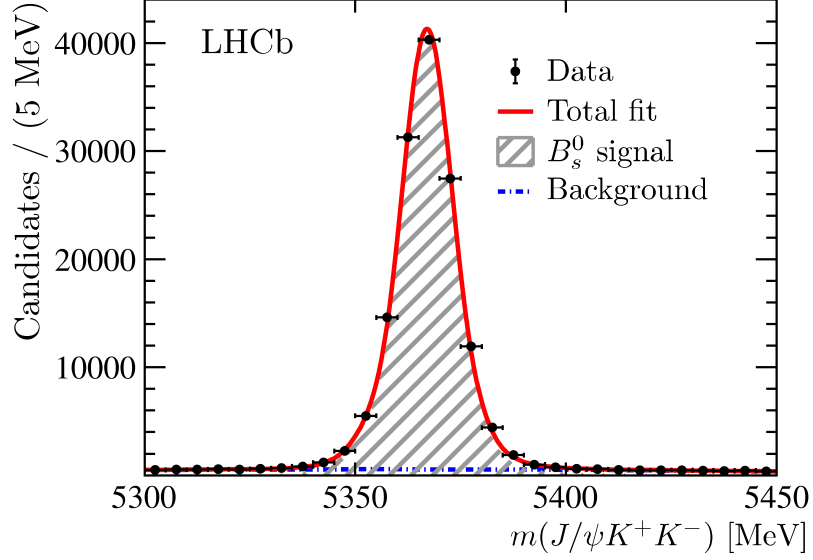
Figure 2: Fit to the $J/\psi K^+ K^-$ invariant-mass distribution for the B_s^0 control mode.
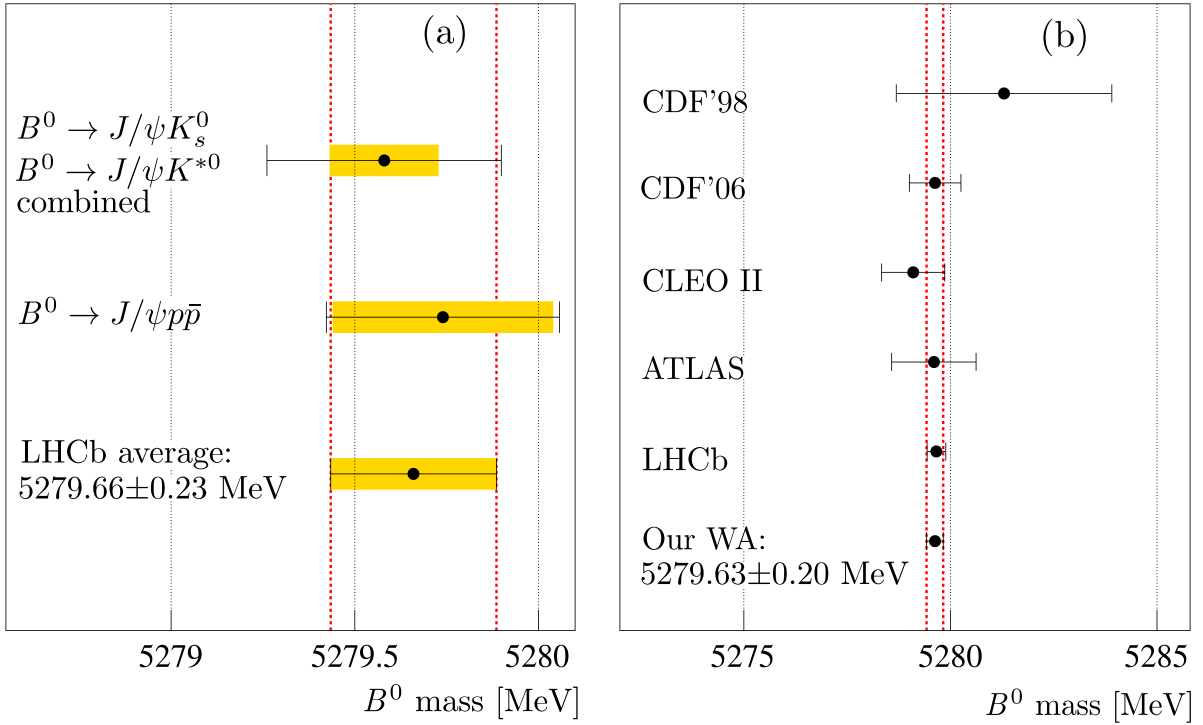

Figure 3: Measurements of B^0 mass from (a) various B_s^0 decay modes in LHCb, (b) world average (WA) including the present result.

World average for the B_s^0 mass

Figure 4 shows the combination of the B_s^0 mass, where the combination of LHCb measurements is obtained considering only the systematic uncertainties derived with the same methods to be correlated.
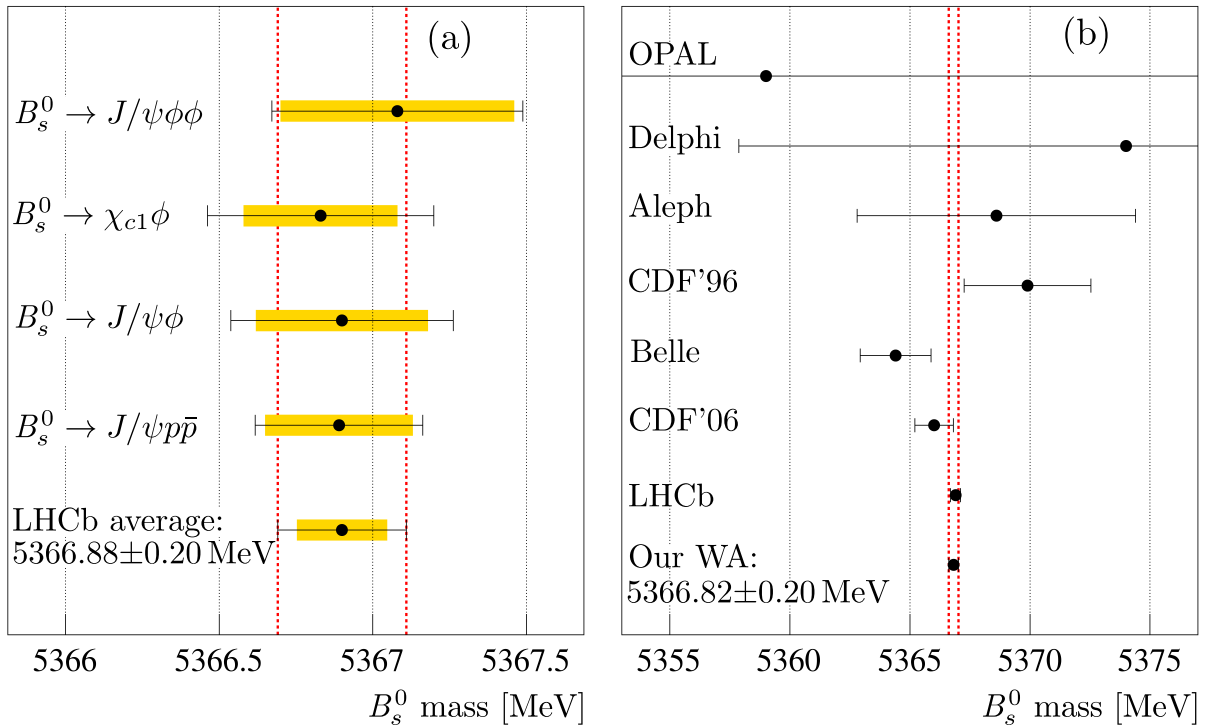
2

Figure 4: Measurements of B_s^0 mass from (a) various B_s^0 decay modes in LHCb, (b) WA including the present result.