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## Measurement of $B_c(2S)$ and $B_c(2S)^*$ cross section ratios in proton-proton collisions at 13 TeV

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The ratios of the  $B_c(2S)$  to  $B_c$ ,  $B_c(2S)$  to  $B_c$ , and  $B_c(2S)$  to  $B_c(2S)$  production cross sections are measured in proton-proton collisions at 13 TeV, using a data sample collected by the CMS experiment at the LHC, corresponding to an integrated luminosity of 143 fb<sup>-1</sup>. The three measurements are made in the  $B_c$  meson phase space region defined by the transverse momentum  $p_T > 15$  GeV and absolute rapidity  $|\eta| < 2.4$ , with the excited  $B_c(2S)$  states reconstructed through the  $B_c \pi^+\pi^-$ , followed by the  $B_c \rightarrow J/\psi \pi^+$  and  $J/\psi \rightarrow \mu^+\mu^-$  decays. The  $B_c(2S)$  to  $B_c$ ,  $B_c(2S)$  to  $B_c$ , and  $B_c(2S)$  to  $B_c(2S)$  cross section ratios, including the unknown  $B_c(2S) \rightarrow B_c \pi^+\pi^-$  branching fractions, are  $(3.47 \pm 0.63 \text{ (stat)} \pm 0.33 \text{ (syst)})\%$ ,  $(4.69 \pm 0.71 \text{ (stat)} \pm 0.56 \text{ (syst)})\%$ , and  $1.35 \pm 0.32 \text{ (stat)} \pm 0.09 \text{ (syst)}$ , respectively. None of these ratios shows a significant dependence on the  $p_T$  or  $|\eta|$  of the  $B_c$  meson. The normalized dipion invariant mass distributions from the decays  $B_c(2S) \rightarrow B_c \pi^+\pi^-$  are also reported.

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