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## Charmonium production using decays to hadronic final states at LHCb

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Non Relativistic QCD (NRQCD) provides so far the most successful framework to describe the production of the  $J^{PC} = 1^{--}$  quarkonium states. However, a comprehensive description of the production and polarisation of the  $J/\psi$  state at Tevatron and LHC in the complete  $p_T$  and rapidity range remains a challenge. The heavy quark spin symmetry yields direct links between the long distance matrix elements describing hadroproduction of different charmonium states. The production of linked charmonium states -  $\eta_c$  and  $J/\psi$ ,  $\eta_c(2S)$  and  $\psi(2S)$ , and the three  $\chi_c$  states - can thus be described simultaneously.

Experimentally the production of non- $1^{--}$  charmonium states can be studied by reconstructing their decays to fully hadronic final states. The LHCb measurement of the  $\eta_c(1S)$  prompt production and production in inclusive b-hadron decays via the decay  $\eta_c(1S) \rightarrow p\bar{p}$  is discussed together with its strong impact on NRQCD-based theory models. Recent LHCb measurement of the  $\chi_c$  and  $\eta_c(2S)$  states production in inclusive b-hadron decays using their decays to  $\phi\phi$  is also presented; the discrepancy with existing theoretical prediction is demonstrated. Prospects of measuring prompt  $\eta_c(2S)$  production at the LHCb using 2018 data is discussed.

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