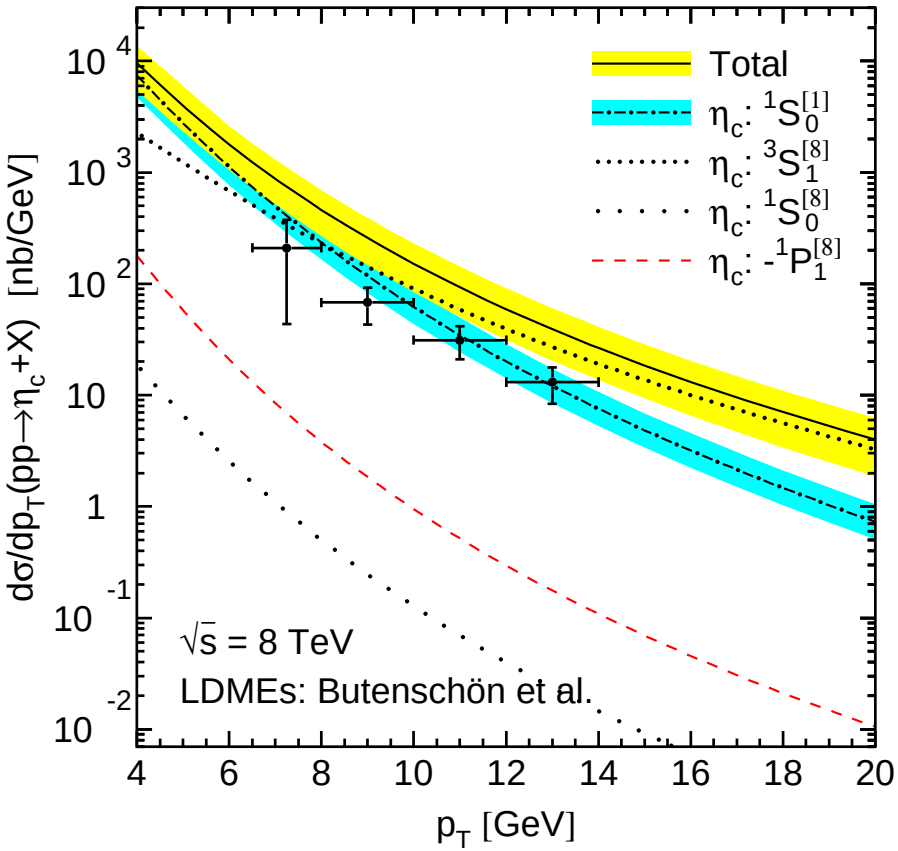
η_c Production at LHCb

Geoffrey Bodwin (ANL)

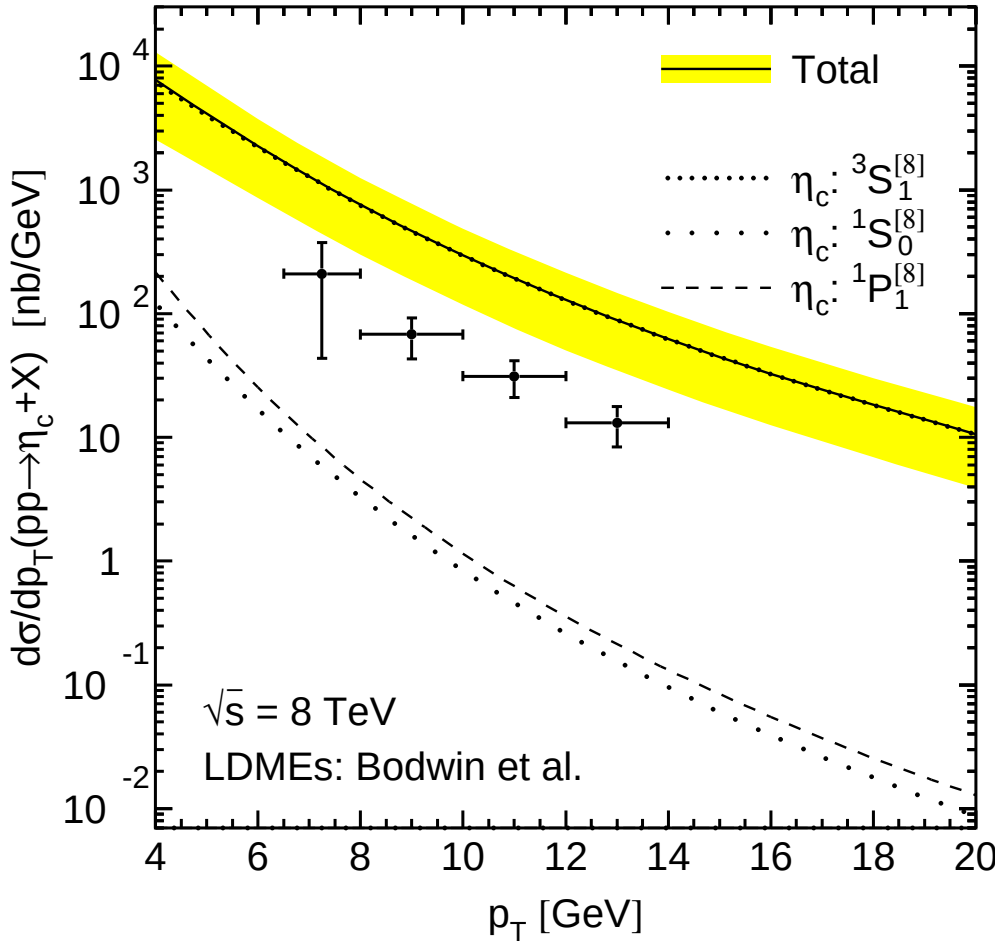
Butenschön and Kniehl (2014)

- The NLO prediction for the η_c cross section overshoots the LHCb (2014) measurement by a factor of about 6.



- The η_c LDMEs are fixed by using the heavy-quark spin symmetry of NRQCD to relate them to the J/ψ LDMEs.
  Good up to corrections of relative order v^2.
- The color-singlet contribution alone accounts for the measured cross section.

- Use of the Bodwin *et al.* LDMEs from LP+NLO fits to the J/ψ cross-section makes the situation worse.

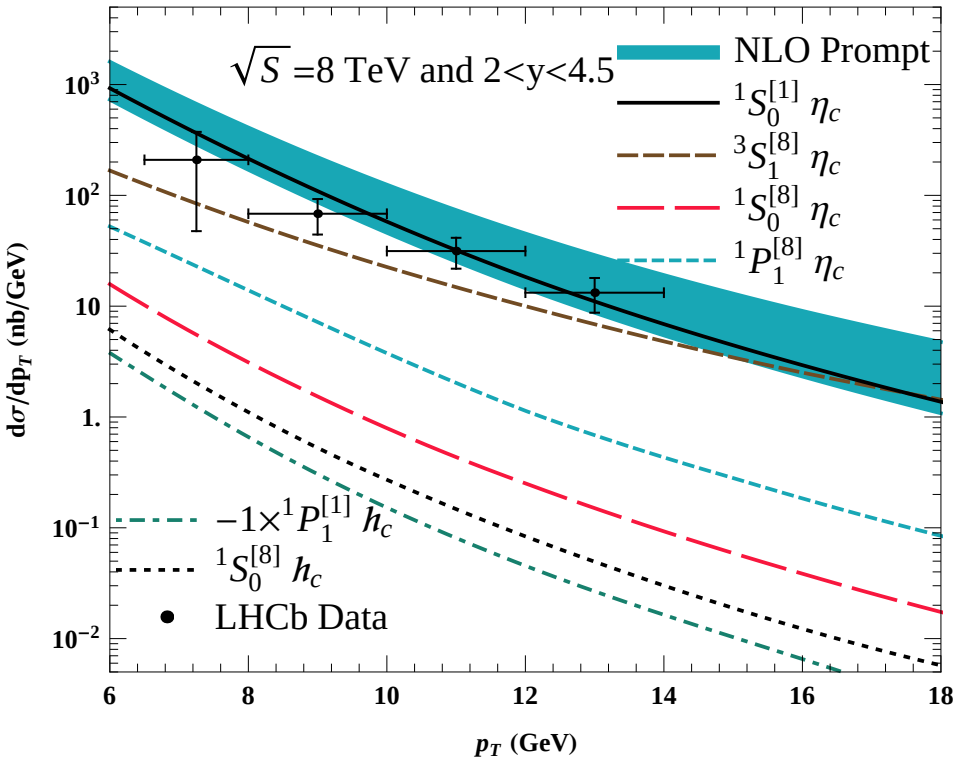


Han, Ma, Meng, Shao, Chao (PKU Group) (2014)

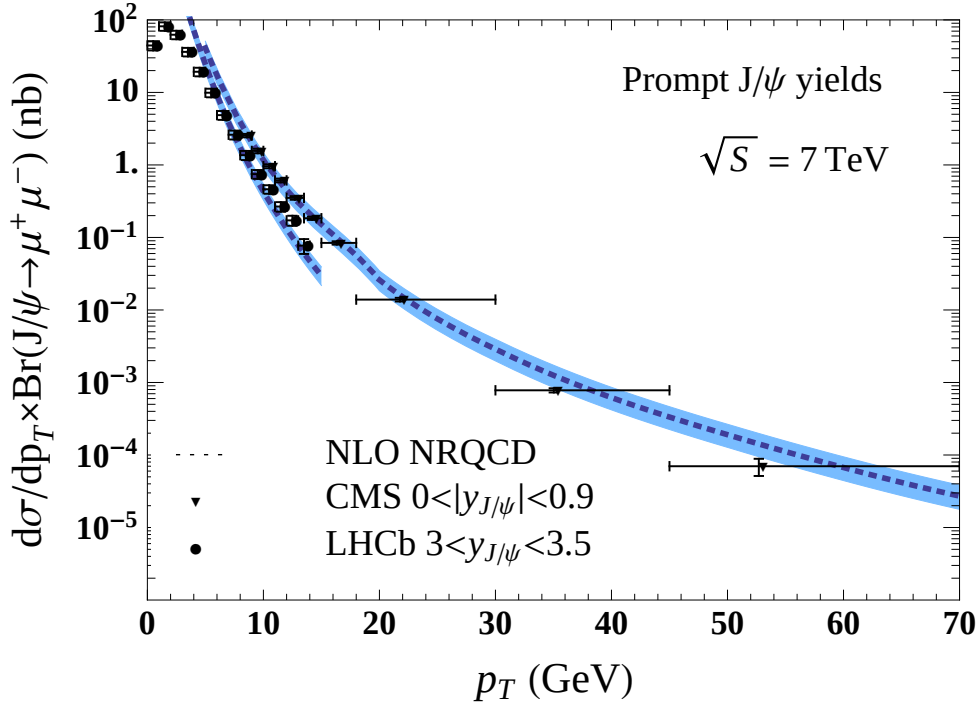
- Apply an additional constraint to the PKU 2010 LDME fit:

$$0 < \langle \mathcal{O}^{\eta_c}({}^3S_1^{[8]}) \rangle < 0.0146 \text{ GeV}^3 \quad \Longrightarrow \quad 0 < \langle \mathcal{O}^{J/\psi}({}^1S_0^{[8]}) \rangle < 0.0146 \text{ GeV}^3$$

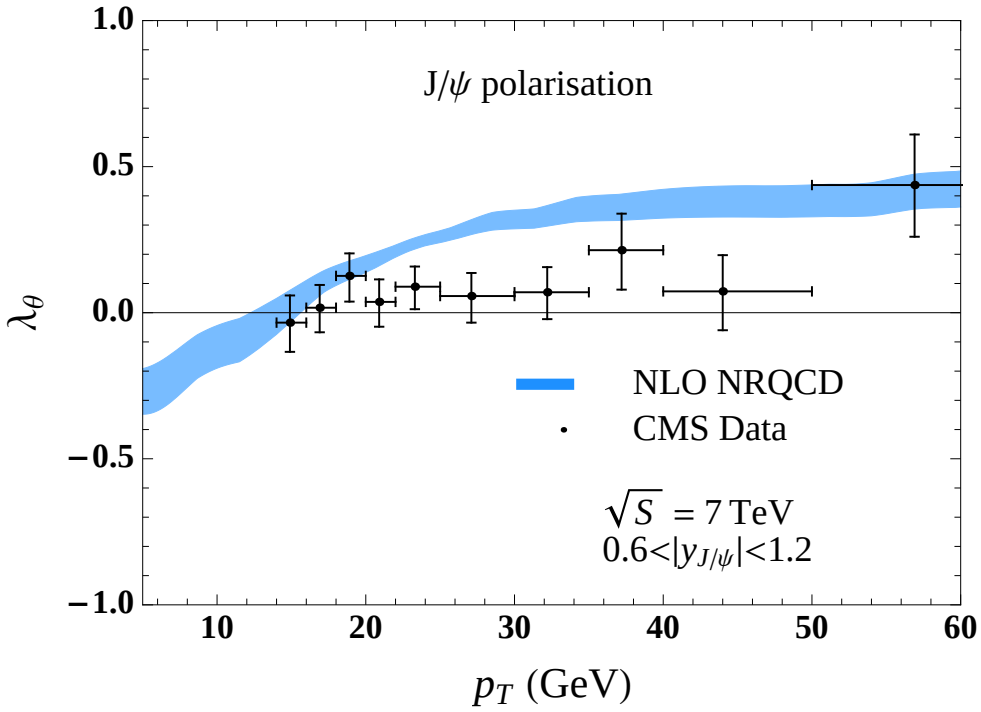
- They obtain reasonable agreement with the η_c cross-section data.



- The fit to the J/ψ cross-section data is still reasonable, as well.



- However, there is tension between the data and the prediction for the J/ψ polarization.



The Issue of $BF(\eta_c \to p\bar{p})$

- LHCb measures the relative η_c and J/ψ rates through decays to the $p\bar{p}$ channel.
- $\mathrm{BF}(\eta_c \to p\bar{p})$ is determined from a global fit to BFs:
  $BF(\eta_c \to p\bar{p}) = (15.0 \pm 1.6) \times 10^{-4}$.
- But there is clearly a lot of tension in the global fit: $\chi^2/\mathrm{d.o.f.} = 117.7/72 \Longrightarrow$
  a probability of less than 0.5% that the fitted values are the result of a random fluctuation.
- Direct measurements of $\mathrm{BF}(\eta_c \to p\bar{p})$ have large uncertainties.

$(15 \pm 5 \pm 1) \times 10^{-4}$	BES3 (2012)
$(15 \pm 6) \times 10^{-4}$	BES (2004)
$(10 \pm 3 \pm 4) \times 10^{-4}$	DM2 (1991)
$(11 \pm 6) \times 10^{-4}$	MRK3 (1986)
$(29^{+29}_{-15}) \times 10^{-4}$	MRK2 (1980)

A 2σ deviation of the BES3 measurement or a 1σ deviation of the DM2 measurement to the low side would boost the cross section by a factor of 3.