

QCD physics measurements at the LHCb experiment

BOOST 2021

Lightning version

Daniel Craik
on behalf of the LHCb collaboration

Massachusetts Institute of Technology

4th August, 2021



Intrinsic charm at the LHCb experiment

BOOST 2021

Lightning version

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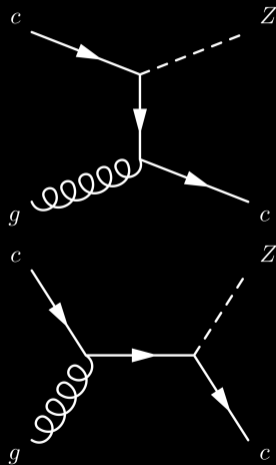
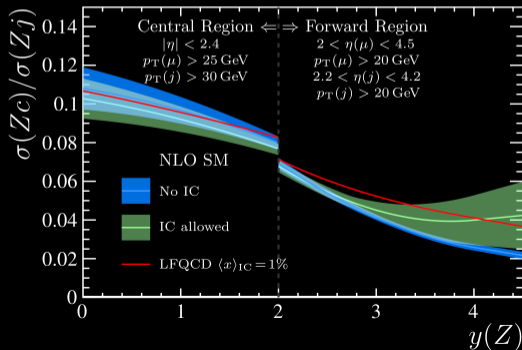
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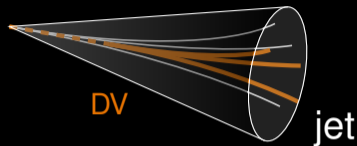
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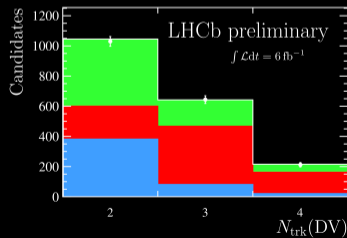
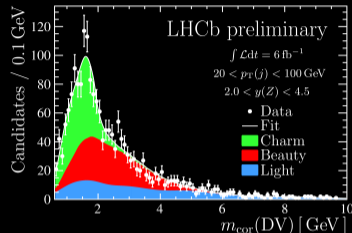


- ▶ Search for valance-like charm in the proton
- ▶ Study production of c -jets in association with a Z
- ▶ Normalise to inclusive $Z + \text{jet}$
- ▶ Forward region sensitive to high- x , high- Q^2 charm content of the proton



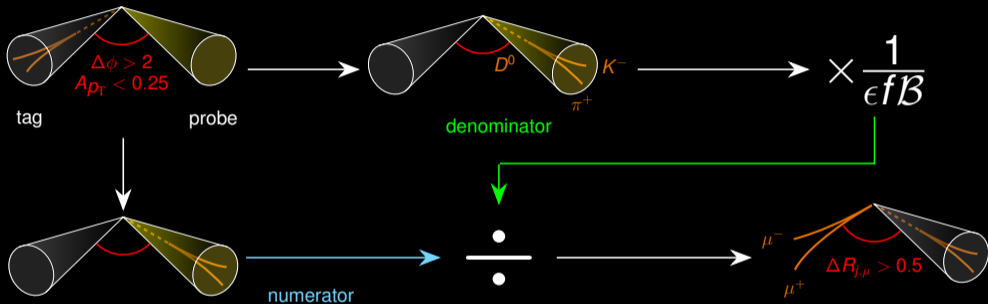


- ▶ Reconstruct displaced vertices within jets
- ▶ Use 2D fit to corrected mass and number of tracks to distinguish **charm** jets from **beauty** and **light**
- ▶ Templates from flavour-enhanced calibration samples
- ▶ Fit in bins of jet p_T and $y(Z)$
- ▶ Determine tagger efficiency using dijet events



Z + c: c-tagger calibration

- ▶ Trigger on DV in “other” jet
- ▶ Tag prompt $D^0 \rightarrow K^- \pi^+$, $D^+ \rightarrow K^- 2\pi^+$
- ▶ Correct for eff, FF and BF



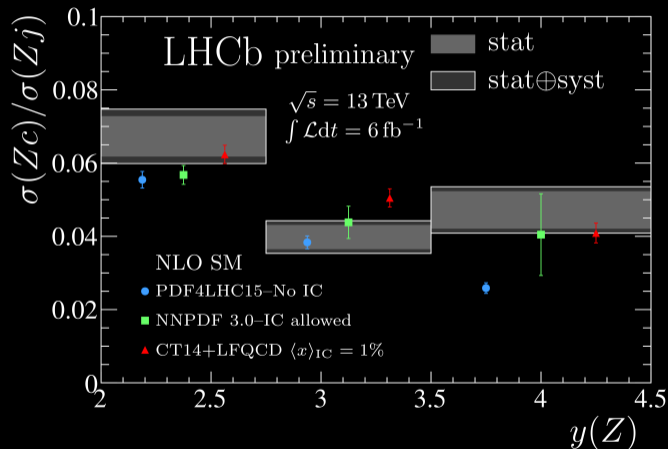
- ▶ Tag DV candidates
- ▶ Divide to get tag efficiency
- ▶ Use for DV-tagged $Z + c$

- ▶ Efficiency determined as function of jet p_T :

$23.9 \pm 1.4\%$, $24.4 \pm 1.9\%$ and $23.6 \pm 4.1\%$ for $p_T \in (20, 30)$, $(30, 50)$ and $(50, 100)$ GeV/c

Source	Relative Uncertainty
<i>c</i> tagging	6–7%
DV-fit templates	3–4%
Jet reconstruction	1%
Jet p_T scale & resolution	1%
Total	8%

- ▶ Leading systematic uncertainty due to *c*-tagging calibration
- ▶ Systematics almost all cancel between $\gamma(Z)$ bins so double ratios have good potential for future precision measurements
- ▶ However, current results are statistically limited



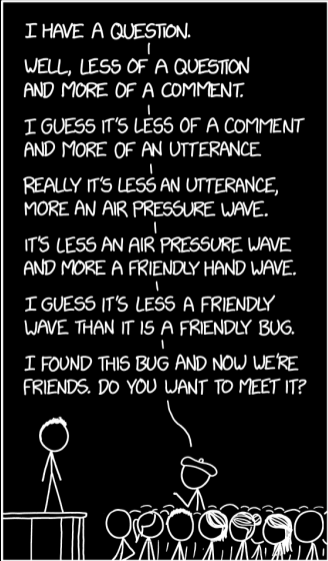
- ▶ Clear enhancement in highest- y bin
- ▶ Consistent with expected effect from $|uudc\bar{c}\rangle$ component predicted by LFQCD
- ▶ Inconsistent with No-IC theory at ~ 3 standard deviations
- ▶ Global PDF analysis required to determine true significance

Summary

- ▶ $Z + c$ in forward region provides first direct probe of IC
- ▶ Clear enhancement in highest- y bin
- ▶ May give first unambiguous evidence for IC in the proton but global PDF analyses required
- ▶ Statistically limited but Run 3 dataset should give definitive answer

Stay tuned!

Questions, utterances or friendly bugs?



xkcd/2191