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QCD physics measurements at LHCb

 m_{ii} [GeV/ c^2

¹University and ²INFN of Padova, contact: <u>davide.zuliani@cern.ch</u> uto Nazionale di Fisica Nucleare

LHCb detector^[1]

- LHCb, originally designed for b- and c-hadron physics, is now considered a general purpose forward detector
- Track momentum resolution: 0.4% at 5 GeV and 0.6% at 100 GeV
- Muon ID efficiency: 97% with 1-3% $\mu \rightarrow \pi$ misidentification
- Electron ID efficiency: 90% with 5% $h \rightarrow e$ misidentification
- Electron reconstruction: bremsstrahlung recovery and well-measured direction
- Excellent vertex reconstruction system \rightarrow tagging of b- and c-jets with reconstruction of secondary vertices formed by tracks inside the jet cone



bb and $c\bar{c}$ di-jet production^[2]

- Heavy flavour di-jet production is an excellent test of pQCD in the forward region
- 2016 dataset (1.6 fb⁻¹) is used to perform differential measurements
- Cross section measured as a function of 4 observables:

leading jet p_T

leading jet n di-jet invariant mass m_{ii}

• Fit to combination of two MVA discriminators to get flavour composition





 $\Delta v^* = 1/2 |y_0 - y_1|$

Cross section ratios $R(c\bar{c}/bb)$ are also determined \rightarrow systematic uncertainty cancellation





Charged hadron production in $Z+jet^{[4]}$

- In the forward region, $Z(\rightarrow \mu\mu)$ +jet production is dominated by guark-jets
- At LHCb it is possible to access jets with lower p_T (from 20 GeV) with respect to ATLAS and CMS
- Three differential distributions are measured for charged hadrons:



- Main differences are due to different fragmentation of quarks and gluons



- Pythia prediction does not exactly match the measurements
- These measurements are important inputs for fragmentation functions in the forward region

Davide Zuliani^{1,2} On behalf of the LHCb Collaboration



Prompt charged particle production in pp collisions at 13 TeV^[5]

- Prompt charged particles: long-lived particles produced in primary interaction or without long-lived ancestors
- Tracks considered: $2 < \eta < 4.8$ and $0.08 < p_T < 10$ GeV \rightarrow loose selection with high efficiency
- Background contributions: fake tracks and secondary particles





• EPOS-LHC and Pythia 8.1 (LHCb tuned) for particle density • Pythia 8.3 for charged ratio

 $m_{
m cor}({
m DV})$ [GeV

Conclusions

3.5

- LHCb is now considered a general purpose forward detector
- QCD physics measurements are performed at LHCb studying a phase space region **complementary** to General Purpose Detectors
- Interesting results have been obtained and models for QCD and pQCD have been tested
- New data and more interesting results are coming with next Runs!

References

- [1] JINST 3 (2008) S08005 [2] JHEP 02 (2021) 023 [3] LHCb-PAPER-2021-029 in prep. [4] Phys. Rev. Lett. 123 (2019) 232001
- [5] LHCb-PAPER-2021-010

