

Open B production at the LHC in NNLO+NNLL QCD

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Open B production at previous colliders

- A wealth of data from the Tevatron and $Spp\bar{S}$ on open B

- Processes considered:

$$p\bar{p} \rightarrow b + X$$

($\hookrightarrow B / \mu / J/\psi / \psi(2S)$)

$$p\bar{p} \rightarrow 2b + X$$

($\hookrightarrow 2B / 2\mu$)

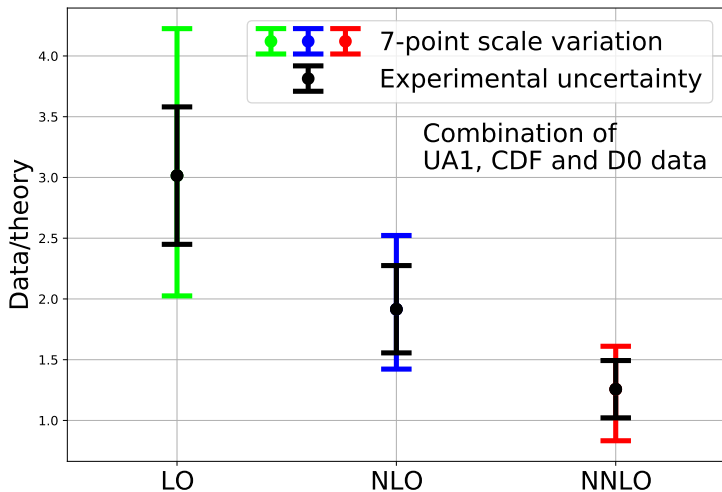
- Previous comparisons to theory: NLO(+NLL)

Cacciari, Greco, Nason (1998)

- Consistently found data/theory $\approx 1.7 \pm 0.5$ (th.)
(initially data/theory ≈ 3 before theory improvements)

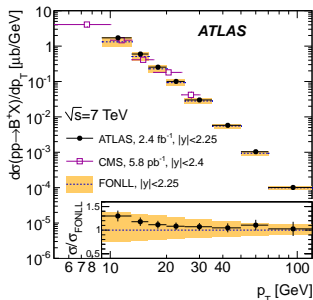
- We can do better: NNLO+NNLL!

Naive combination of 10 measurements:

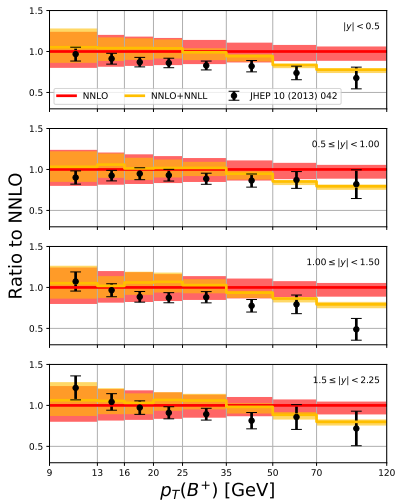
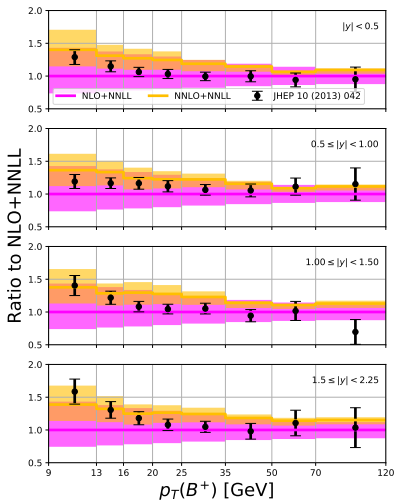


Open B production at the LHC

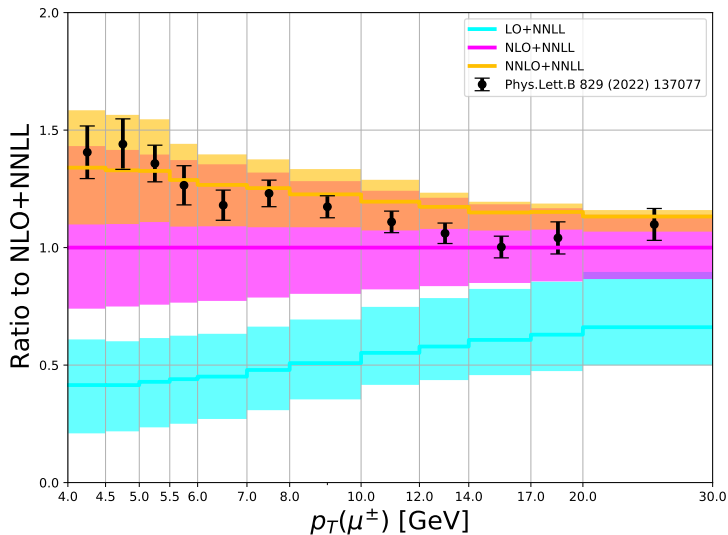
- Much nicer data available from (all four) LHC experiments
- No '*b*-quark-level data', but many different decay modes
- More extreme kinematics: higher rapidity and much higher p_T
- General picture at NLO+NLL (FONLL):
 - Large theory uncertainty at low p_T
 - Shape difference (but within uncertainty)
 - More precise at high p_T
 - Experiment generally much more precise
- High time the predictions were updated!



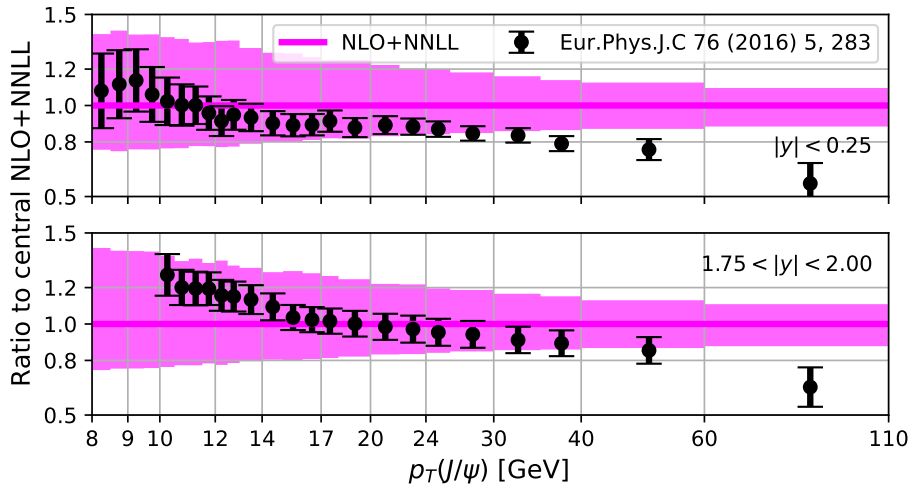
New results: B^+ spectrum at 7 TeV LHC (ATLAS)



New results: μ^\pm from B -hadrons at 5.02 TeV (ATLAS)

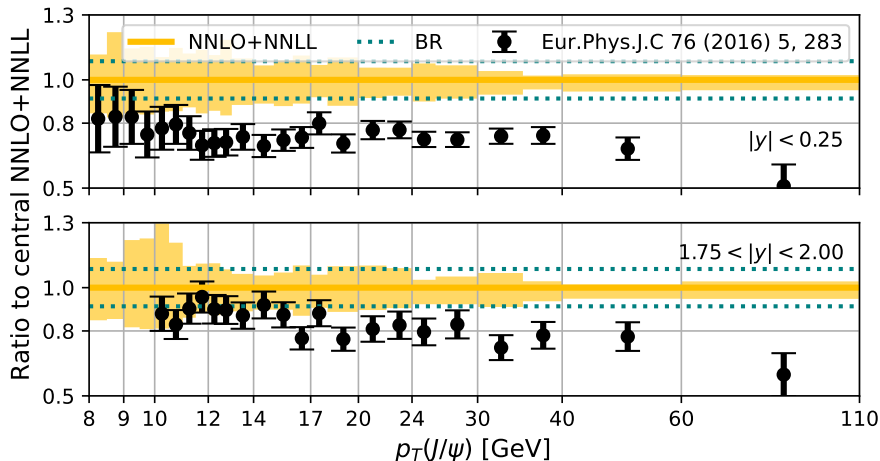


Old result: J/ψ from B -hadrons at 8 TeV (ATLAS)



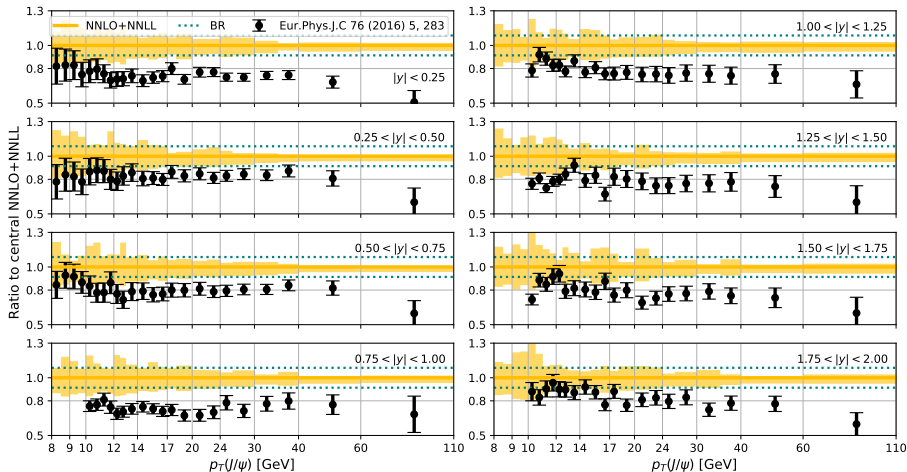
Clear deviation of some kind, but hard to interpret

New results: J/ψ from B -hadrons at 8 TeV (ATLAS)



No more shape difference: deviation is just a constant factor!

New results: J/ψ from B -hadrons at 8 TeV (ATLAS)



Most probably solution: $\text{BR}(B \rightarrow J/\psi)$ is off by 25% (3σ)

BR($B \rightarrow J/\psi$)

- Most probably solution: BR($B \rightarrow J/\psi$) is off by 25% (3σ)
- Fully inclusive BR
- High-energy mixture of B -hadrons
(40.8% B^0 , 40.8% B^+ , 10% B_s , 8.4% Λ_b)
- Current PDG value: $(1.16 \pm 0.10)\%$
- Based on LEP measurements from the 90s
- Could probably do with an update...
- Will try 'proper' fit using our predictions, but not ideal
- Cannot be measured at BELLE (II)
- Due to low \sqrt{s} , only 50/50 mixture of B^0 and B^+ measurable

BR($B \rightarrow J/\psi$)

- BR($B \rightarrow J/\psi$) for BELLE mixture: $(1.094 \pm 0.032)\%$ (lower!)
- BR($B_s \rightarrow J/\psi$) expected to be similar
- BR($\Lambda_b \rightarrow J/\psi$) expected to be much lower
- Non-prompt $\psi(2S)$ spectrum shows similar deviation
- BR($B \rightarrow \psi(2S)$) only known as ratio to BR($B \rightarrow J/\psi$)
⇒ Expect correlated deviations
- All suggests BR for the high-energy mixture lower than 1.16%
- Measurement by LHCb?

Conclusion & outlook

- Better description of open B at NNLO+NNLL
- Smaller uncertainties (competitive with experiment at high p_T)
- Shape difference observed at NLO disappeared
- No comparison to LHCb data for now, but in the works
- New interpretation of old deviation for non-prompt J/ψ
- New interpretation not possible at NLO: need NNLO!
- Suggests remeasuring $\text{BR}(B \rightarrow J/\psi)$ could be interesting

Interested to hear your input, both on the production spectra and on $\text{BR}(B \rightarrow J/\psi)$!