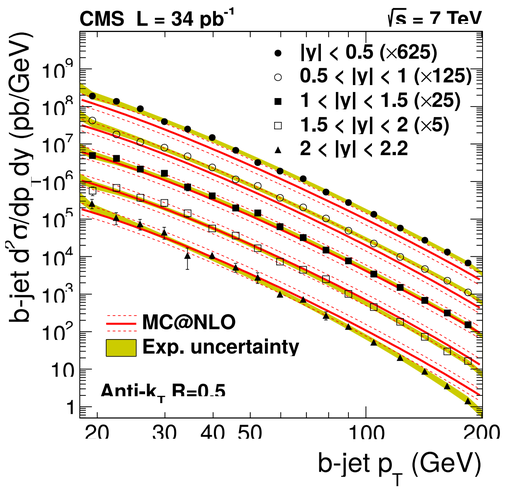
Measurement and study of inclusive b jet production with 2016 data.

Patrick L.S. CONNOR, Hannes JUNG, Paolo GUNNELLINI, Radek ŽLEBČÍK

Previous measurement [1]



B tagging is challenging at high p_t

In 2016

> 1000x larger luminosity
> Higher energy in c.m.s.
> Improved performance of b tagging

→ **TeV scale can be reached!**

The analysis in a nutshell

Measurement of **double differential cross section** with anti-k_t jet clustering algorithm (R = 0.4) and **fraction** in inclusive jet production

Perform unfolding with simulation corrected to the data

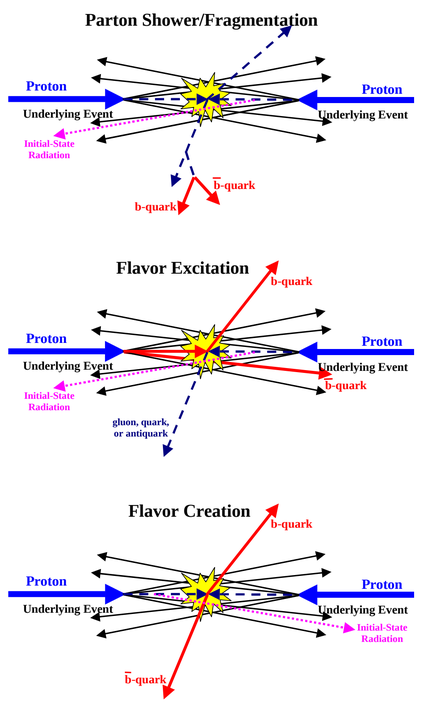
Corrections to simulation

> **PU corrections**: sampling correction and profile reweighting
> **JECs**: scale and resolution
> **B tagging**: CSVv2, calibration (standard + additional correction)

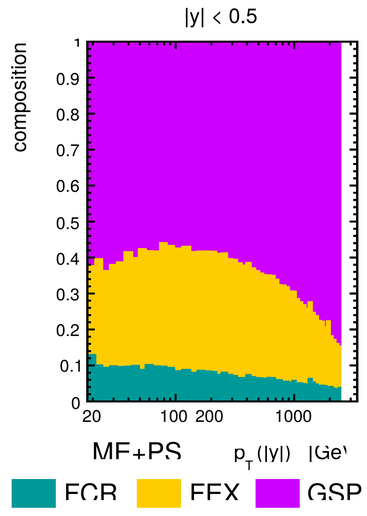
Corrections to data

> **Trigger**: emulation & tag-and-probe methods
> **JECs**: scale only
> **Unfolding**: regularisation with Tikhonov, cross-checked with D'Agostini

Production modes

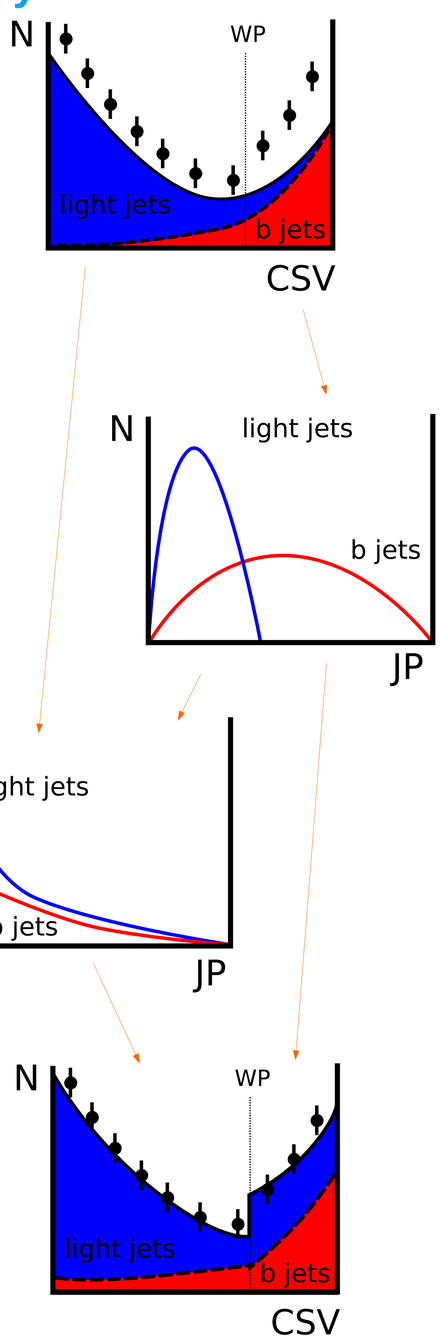


Inclusive b jet is more sensitive to extra radiation than inclusive jet production



Figures from [2]

Purity fit

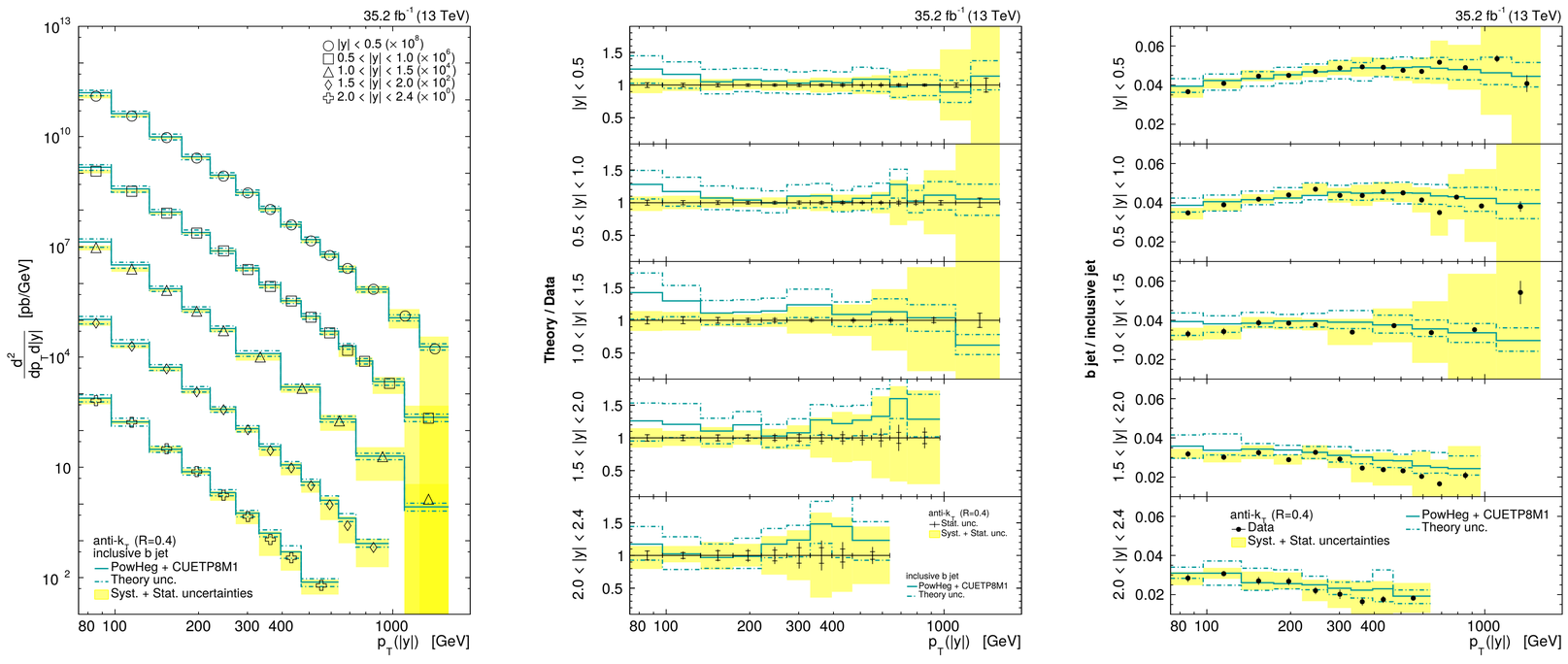


$$\begin{bmatrix}\sigma_b\\ \sigma_n\end{bmatrix} = \begin{bmatrix}P_{b\hat{b}} & 1-P_{n\hat{n}}\\ 1-P_{b\hat{b}} & P_{n\hat{n}}\end{bmatrix} \times \begin{bmatrix}\sigma_{\hat{b}}\\ \sigma_{\hat{n}}\end{bmatrix}$$

In 2016

> Template fit of JP in CSV-tagged region
> Extrapolate fit parameter for b component in non-CSV-tagged region
> Rescale the non-b component to fit the data in non-CSV-tagged region
→ **dominant systematic uncertainty**

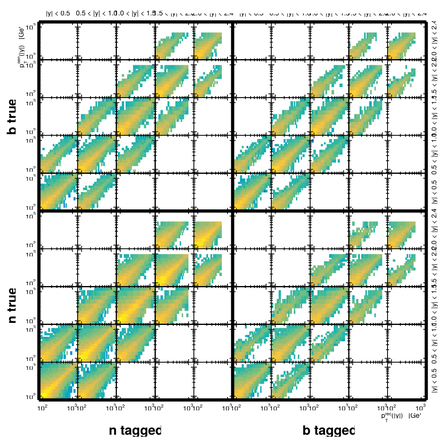
Result



> Data compared to **Powheg + Pythia 8** prediction
> **Agreement** is observed up to the TeV scale!

Unfolding

$$\chi^2 = \underbrace{(\mathbf{y}-\mathbf{Ax})^T \mathbf{V}_y^{-1} (\mathbf{y}-\mathbf{Ax})}_{\text{inversion}} + \underbrace{\tau^2 ||\mathbf{Lx}||^2}_{\text{regularisation}}$$



Tikhonov regularisation [3]

> Performed with TUnfold package [4,5]
> Regularisation is adapted to steeply falling p_t spectrum
> 3D unfolding is most appropriate to deal with background and low purities

Systematics

> All uncertainties are inferred at hadron-level by unfolding with variations of the simulation samples.

Cross-checks

> D'Agostini
> Bottom Line Test
> Closure tests

$$\mathbf{L} = \begin{bmatrix} 0 & \dots & 0 & 0 & \frac{1}{x^{MC}_{j_3}} & -\frac{1}{x^{MC}_{j_3}} - \frac{1}{x^{MC}_{j_1}} & \frac{1}{x^{MC}_{j_1}} \\ 0 & \dots & 0 & \frac{1}{x^{MC}_{k_3}} & \frac{1}{x^{MC}_{k_3}} - \frac{1}{x^{MC}_{k_1}} & \frac{1}{x^{MC}_{k_1}} & 0 \\ 0 & \dots & \frac{1}{x^{MC}_{l_3}} & \frac{1}{x^{MC}_{l_3}} - \frac{1}{x^{MC}_{l_1}} & \frac{1}{x^{MC}_{l_1}} & 0 & 0 \\ & & \vdots & \vdots & \vdots & \vdots & \vdots \\ & & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Prospects

This analysis (SMP-17-007)

> Analysis was pre-approved
> Discussions are ongoing with ARC and BTV

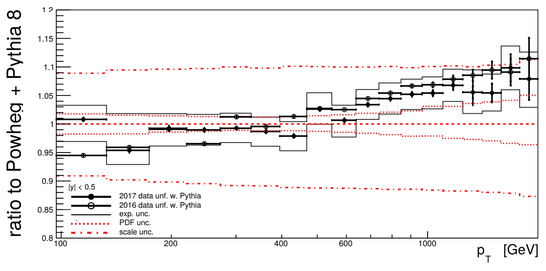
Extensions

> Cross check fit of JP with a fit of SV
> Full Run-II measurement with DeepCSV

Further measurments

> Low-p_t b jets
> c jet measurement
> Back-to-back topologies

Apetiser



Inclusive jet production in 2016 and 2017 data!

[1] Serguei Chatrchyan et al. "Inclusive b-jet production in pp collisions at s = 7 TeV". In: JHEP 04 (2012), p. 084. doi: 10.1007/JHEP04(2012)084. arXiv: 1202.4617 [hep-ex]
[2] R. D. Field. "The Sources of b quarks at the Tevatron and their correlations". In: Phys. Rev. D65 (2002), p. 094006. doi: 10.1103/PhysRevD.65.094006. arXiv: hep-ph/0201112 [hep-ph]
[3] Andreas Hocker and Vakhtang Kartvelishvili. "SVD approach to data unfolding". In: Nucl. Instrum. Meth. A372 (1996), pp. 469–481. doi: 10.1016/0168-9002(95)01478-0. arXiv: hep-ph/9509307 [hep-ph]
[4] Stefan Schmitt. "TUnfold: an algorithm for correcting migration effects in high energy physics". In: JINST 7 (2012), T10003. doi: 10.1088/1748-0221/7/10/T10003. arXiv: 1205.6201 [physics.data-an]
[5] Stefan Schmitt. "Data Unfolding Methods in High Energy Physics". In: EPJ Web Conf. 137 (2017), p. 11008. doi: 10.1051/epjconf/201713711008. ArXiv: 1611.01927 [physics.data-an]