LHCC Poster Session - CERN, 13 March 2013

Measurement of the B^+ meson production at high p_T with the ATLAS detector

Reference:
ATLAS-CONF-2013-008

Motivation

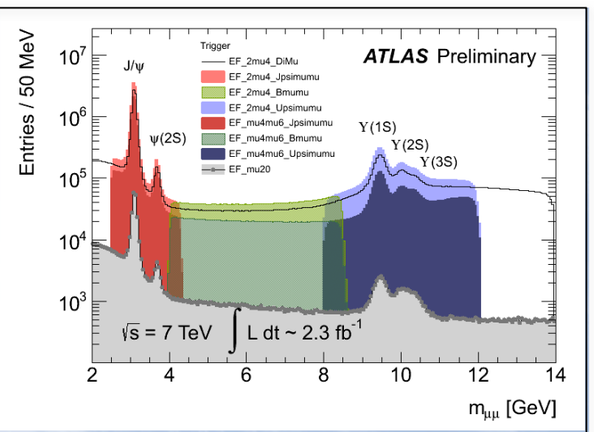
The production of of B-hadrons at the LHC is a test of QCD calculations at the new regime, in wider range of rapidity (y) and transverse momentum (p_T) than previous studies at hadron colliders. ATLAS measures the production of B-hadrons in the central rapidity region and can reach B-hadrons of high transverse momentum (~100 GeV). ATLAS measurements are interesting for testing the validity of FONLL approximations, which are expected to be valid for $p_T >> m_b$. Current predictions depend on renormalisation and factorisation scales and the b-quark mass, resulting in large theoretical uncertainties. Using 2.4 fb^{-1} of data at 7 TeV, ATLAS provides a double differential cross section measurement, allowing detailed comparisons with NLO predictions.

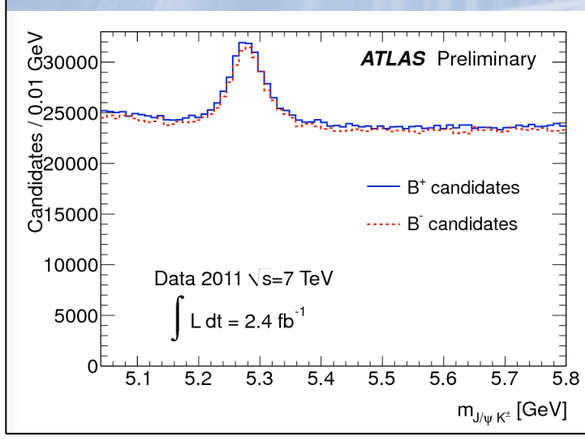
$B^\pm \rightarrow J/\psi\ K^\pm$

This channel provides a reference for rare B-decays and a base for detailed performance studies due to large available statistics with respect to other B-mesons.

Event Selection

- Data collected during 2011 using a dimuon trigger with both p_T thresholds at 4 GeV
- Dimuons in the invariant mass range 2.7-3.3 GeV are considered as J/ψ candidates
- Selected J/ψ candidates are fitted to a common vertex with an additional charged track, which is assigned the $K^\pm$ mass





- $B^\pm$ candidates with a good vertex fit quality ($\chi^2/N_{d.o.f.}<6$) are retained in the invariant mass range 5.040 - 5.800 GeV
- Signal yields from 2.4 fb^{-1} of data:

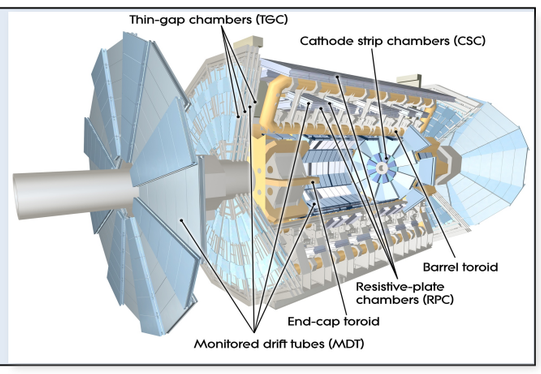
B^+: 63531 ± 838$_{(stat.)}$
B^-: 62093 ± 842$_{(stat.)}$

~3% difference due to the reconstruction efficiencies of K^+/K^- mesons

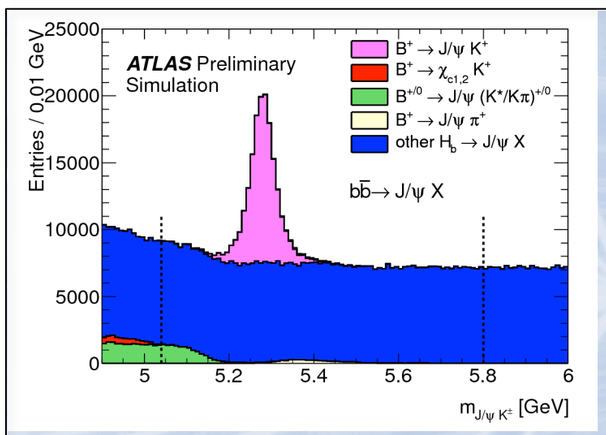
A total of 125k $B^\pm$ signal events is used for the cross section measurement

The ATLAS Detector

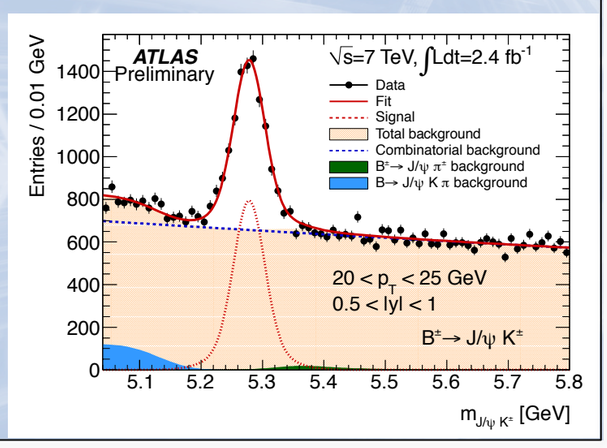
ATLAS, having a sophisticated muon system extended over a large region of solid angle, can reconstruct dimuon final states with high efficiency. With highly selective dimuon triggers, decays containing a J/ψ meson can be identified. The B-hadron exclusive decays containing a J/ψ are reconstructed based on the dimuon signature.



Extraction of the signal yield



- Example of likelihood fit to data



- Backgrounds:
  - Resonant ($B^\pm \rightarrow J/\psi\ \pi^\pm$, $B \rightarrow J/\psi\ K\ \pi$)
  - Combinatorial ($pp \rightarrow J/\psi\ X$, $B \rightarrow J/\psi\ X$)

Cross section determination

$$\frac{d^2\sigma(pp \rightarrow B^+X)}{dp_T dy} = \frac{N^{B^+}}{\mathcal{L} \cdot \mathcal{B} \cdot \Delta p_T \cdot \Delta y}$$

$$N^{B^+} = \frac{N^{B^+}_{rec}}{A \cdot \varepsilon^{B^+}} = \frac{N^{B^-}_{rec}}{A \cdot \varepsilon^{B^-}} = \frac{N^{B^\pm}_{rec}}{A(\varepsilon^{B^+} + \varepsilon^{B^-})}$$

Reporting results for B^+ cross section (equal to B^- cross section within available precision in the accessible phase space)

Using both reconstructed states, easily doubling the statistics

Take into account the different efficiencies of B^+ and B^- signal decays

...where:

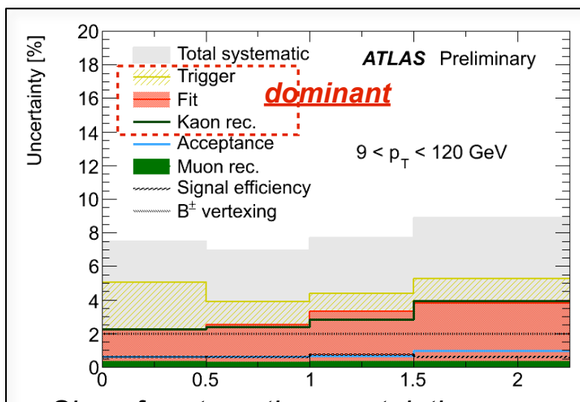
$\mathcal{B}$ *total branching ratio* (~6×10^{-5})

$\mathcal{L}$ *integrated luminosity* (2.4 ± 0.04 fb^{-1})

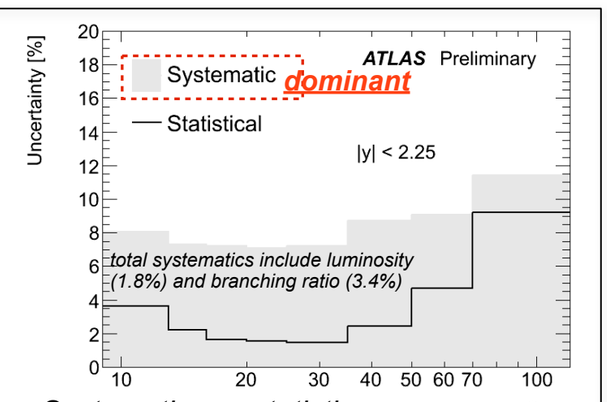
$N^{B^\pm}_{rec}$ *result of fit to $B^\pm$ candidates*

$A \cdot \varepsilon^{B^{+/-}}$ *signal efficiency from simulation*

Systematic and Statistical Uncertainties



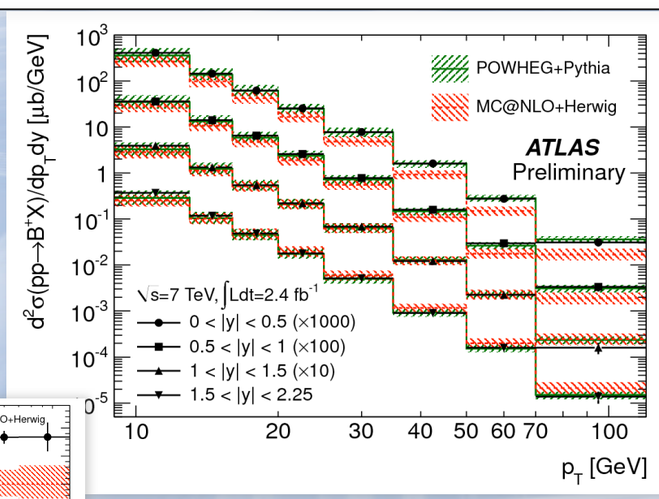
Size of systematic uncertainties

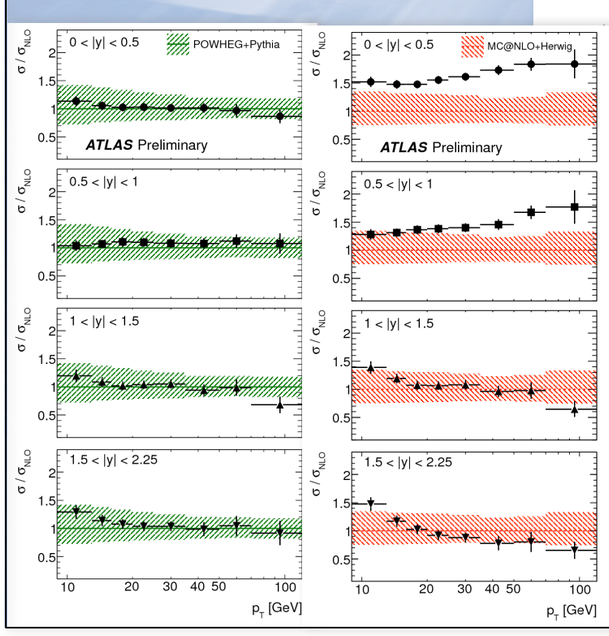


Systematics vs statistics

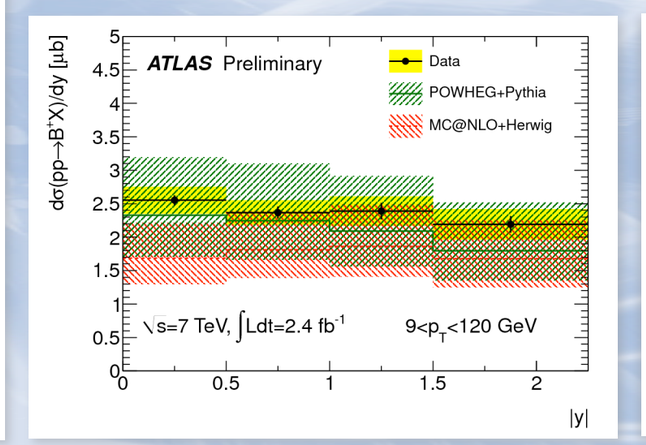
Results and comparisons with theoretical predictions

- Covering the range: $|y|<2.25$, 9 GeV<p_T<120 GeV
- Detailed comparisons with NLO predictions, from POWHEG+Pythia and MC@NLO (CT10, m_b=4.75 GeV)
- Predictions quoted with uncertainties from renormalisation and factorization scale and b-quark mass

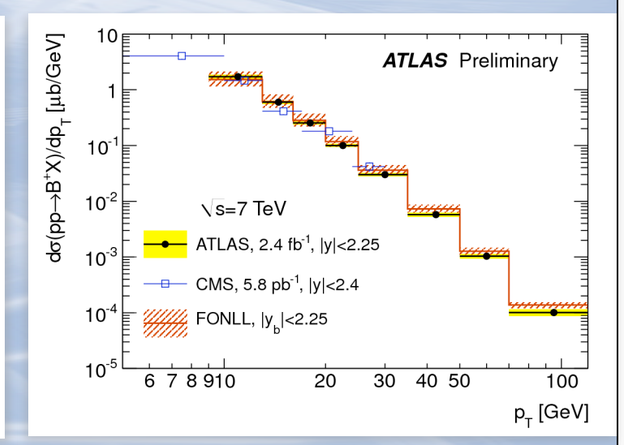




- Integrating results over p_T:



- Integrating results over y:



Summary and Conclusions

The differential cross section for B^+ meson production has been studied in pp collisions at 7 TeV with 2.4 fb^{-1} of integrated luminosity, covering the range $|y|<2.25$ and 9 GeV < p_T < 120 GeV. The measured differential cross section is compared with the predictions of NLO QCD computations from POWHEG+Pythia and MC@NLO. The predictions are quoted with an uncertainty from renormalisation and factorisation scales and b-quark mass of the order of 20%-40%. Within these uncertainties, POWHEG +Pythia is altogether in agreement with the measurement in absolute scale and in the dependences on p_T and y. At low $|y|$, MC@NLO predicts lower production cross section and a softer p_T spectrum than the one observed in data, which becomes harder for $|y|>1$. An FONLL calculation for $\sigma(pp \rightarrow bX)$, assuming a hadronisation fraction of $f_{b \rightarrow B^+}$ of (40.1±1.3)% to fix the overall scale, is in good agreement with the measurement of $d\sigma/dp_T$, in particular for p_T<30 GeV.

*More ATLAS results on b-production with **b-jets**[1], **b→D*μX decays**[2] and **inclusive muons/electrons**[3]:*
[1] **Eur.Phys.J.C 71 (2011) 1846** , [2] **Nucl. Phys. B 864 (2012) 341-381**, [3] **Phys.Lett. B707 (2012) 438-458**

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ATLAS EXPERIMENT