HEAVY FLAVOUR PRODUCTION AT ATLAS

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Abstract. The production of heavy flavours at LHC provides an opportunity for a new insight into QCD. The ATLAS detector provides data at higher transverse momenta and wider rapidity ranges than have previously been studied. Both Charmonia [2] and Bottomonia [3] production cross sections have been measured in proton-proton collisions at centre of mass energy of 7 TeV as a function of transverse momentum and rapidity. Exclusive B and D meson states have been also reconstructed ([4–6]). Results are compared to theoretical predictions of various QCD models.

1 The ATLAS Detector

ATLAS [1] is a multi-purpose experiment at the LHC designed primarily to search for Higgs bosons and signs of new physics beyond the Standard Model. In addition it has a broad flavour physics program. The key elements of the detector for this study are the Inner Detector and Muon Spectrometer. The Inner Detector provides precise tracking information measuring charged particles with silicon pixels, silicon strips detectors and a transition radiation tracker, immersed in a 2T solenoidal magnetic field and covers the pseudorapidity range $|\eta| < 2.5$. The Muon Spectrometer consists of several types of detectors sitting in a toroidal magnetic field with a strength ~ 0.5 T and covers $|\eta| < 2.7$. It can measure muon transverse momentum with a relative uncertainty of 10% up to momenta of ~ 1 TeV. The Muon Spectrometer also provides information for muon triggers - a key to the most of heavy flavour studies as muons are the clean signature of heavy flavours involved processes.

2 Quarkonia Production

Measurements of J/ψ and Υ production and properties in ATLAS are important steps both for understanding the detector performance and for performing measurements of various B-physics channels. It also provides a testing ground for studies of the muon trigger and identification efficiencies and momentum scale and resolution. The resulting dimuon invariant mass spectra obtained with 0.24 fb^{-1} of data recorded on 2010-2011 are shown at Fig. 2. The plots show all oppositely charged di-muon pairs, passing vertexing, in the J/ψ and $\psi(2S)$ mass range (left) and in the $\Upsilon(1S, 2S, 3S)$ mass range (right). Events which fire a variety of di-muon triggers, with one or two muons at level 1 confirmed at the high level trigger (HLT), are included. The pair of muons are

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required to have a minimum p_T of (2.5, 4) GeV as calculated by the offline reconstruction. The fitted mass values are in the good agreement with the PDG averages.

Figure 1: The dimuon mass spectra in the mass regions of J/ψ and $\psi(2S)$ (left) and $\Upsilon(1S, 2S, 3S)$ (right).

ATLAS has measured the inclusive J/ψ production cross section and the production fraction of non-prompt J/ψ (produced via the decay of a B-hadron) to inclusively produced J/ψ . The 2.3 pb^{-1} of data collected in 2010 has been used in the analysis. The low luminosity 2010 data was employed to allow loose trigger selections in order to obtain a sufficient statistics at lower p_T . The doubly differential cross-sections for J/ψ production in bins of rapidity and p_T has been derived. Details of analysis can be found in [2]. The resulting inclusive differential cross-section for one of the four rapidity bins is shown in Fig. 2 as a function of J/ψ p_T . Differential production cross-sections of prompt and non-prompt J/ψ was separately determined and compared to several QCD models predictions. ATLAS also provides a measurement of the fiducial differential production cross-section of $\Upsilon(1S)$ mesons decaying into two muons with $p_T > 4 \text{ GeV}$ and $|\eta| < 2.5$. Fig. 3 shows $\Upsilon(1S)$ cross-section as a function of $p_T^{\Upsilon(1S)}$ for the central rapidity bin in comparison with theory predictions (details can be found in [3]).

3 D and B-mesons study

Open charm mesons have been reconstructed in ATLAS via the channels $D_s^+ \rightarrow \phi\pi \rightarrow (KK)\pi$ and $D^+ \rightarrow K\pi\pi$. The fitted mass are in a good agreement with PDG values. The differential cross section for $D^{*\pm}$ derived from this signals are shown at Fig. 4 with respect to the D-meson p_T [5]. The inclusive B-mesons study is an important step for future studies of CP-violation effects and rare b-hadron decays. Several important modes has been reconstructed ($B^\pm \rightarrow J\psi(\mu\mu)K^\pm$, $B^0 \rightarrow J\psi(\mu\mu)K^*(K\pi)$) (Fig. 5 $B^\pm \rightarrow J\psi(\mu\mu)\phi(KK)$) ([5–7]). The life-time measurements are in agreement with world averages.

4 Conclusion

After the first year of data-taking ATLAS has provided many interesting results in the heavy flavour sector and is prepared to many new measurements for stress tests of Standard Model and search beyond (CP-violation, new states, rare decays etc.)

Figure 2: J/ψ cross-section for $|y| < 0.75$.

Figure 3: $\Upsilon(1S)$ cross-section for $|y| < 1.2$.

Figure 4: $D^{*\pm}$ diff. cross-section.

Figure 5: $B^0 \rightarrow J\psi(\mu\mu)K^*(K\pi)$ signal.

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