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Measurements of the associated production of vector bosons and heavy flavours with the CMS detector

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Summary. — Different analyses measuring final states with a vector boson and heavy quarks are presented, based on the data collected by the CMS experiment at the LHC in 2010 and 2011.

PACS 13.85.Lg – Total cross sections.
PACS 13.38.Dg – Decays of Z bosons.
PACS 13.87.Ce – Jets production.

1. – Measurement of the $Z/\gamma^* + b\,\mathrm{jet}$ inclusive cross section [1]

The main motivation to study this channel is to confirm or constrain theoretical predictions for these processes. Moreover, it is a benchmark for the search for new physics, for example in the $bb + \Phi$ channel in the MSSM with large $\tan\beta$, and a background in the search for the SM Higgs boson.

The cross section formula used is the following:

$$\sigma(pp \to Z/\gamma^* + b, Z/\gamma^* \to \ell\ell) = \frac{N_{\ell\ell+b} \times (\mathcal{P} - f_{t\bar{t}})}{\mathcal{A}_\ell \times \mathcal{C}_{hadron} \times \epsilon_\ell \times \epsilon_b \times \mathcal{L}}, \qquad \ell = e, \mu, \tag{1}$$

where $N_{\ell\ell+b}$ is the number of selected events, $\mathcal{P}$ is the b-purity, $f_{t\bar{t}}$ the fraction of $t\bar{t}$ contamination, $\mathcal{A}_\ell$ is the lepton acceptance, $\mathcal{C}_{hadron}$ a correction factor for reconstruction effects, $\epsilon_{\ell(b)}$ the lepton (b-tagging) efficiency and $\mathcal{L}$ is the integrated luminosty ($2.11\,\mathrm{fb}^{-1}$).

The cross section is measured in the kinematical region in which $p_T^b > 25\,\mathrm{GeV}$, $|\eta^b| < 2.1$, $60\,\mathrm{GeV} < m_{\ell\ell} < 120\,\mathrm{GeV}$, $\Delta R(\ell, jet) < 0.5$, where $\Delta R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2}$.

Leptons and jets are selected accordingly to standard identification criteria and kinematical cuts used in the CMS collaboration. The b-tagging algorithm looks for a secondary vertex, built from at least 3 tracks, inside jets.

The main backgrounds in this analysis are due to $Z + \mathrm{light\,jets}$ and $t\bar{t}$. The first is subtracted by extracting the "per event" b-purity ($\mathcal{P}$) from a template fit to the secondary

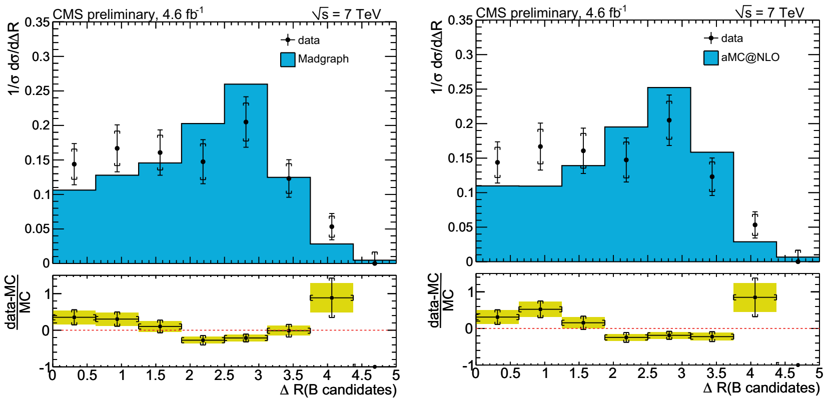

Fig. 1. – $Z/\gamma^* + BB$ differential cross section as a function $\Delta R(BB)$ compared to LO (left) and NLO (right) Monte Carlo.

vertex mass distribution, while the second is estimated from the upper sideband of the $m_{\ell\ell}$ distribution and subtracted from the number of selected events (see eq. (1)).

All the correction factors, except $\mathcal{P}$ and $f_{t\bar{t}}$ described above, are estimated from MC, after having reweighted it to match the lepton and b-tagging efficiencies measured in data and the pile-up (multiple proton-proton interactions in the same bunch crossing) conditions observed in the 2011 data taking.

The result, combining the ee and the $\mu\mu$ channels, is $5.84 \pm 0.08(\text{stat.}) \pm 0.72(\text{syst.})\,^{+0.25}_{-0.55}(\text{theory})\,\text{pb}$. The MCFM [2] NLO prediction, corrected for non-perturbative effects, is $3.97 \pm 0.47\,\text{pb}$, so the measured value is found to be larger than the predictions. The reason for this discrepancy is still under study.

2. – Angular correlation between BB-pair with Z/γ^*+ secondary vertices [3]

The angular correlation between the BB-pair may help to better understand the mechanisms that lead to the production of a Z boson and a pair of B-hadrons at the LHC (b-quarks fusion, gluon splitting, multiple parton interactions).

The analysis reported here relies on the identification of displaced secondary vertices with no use of jets, that allows to study the BB production even at small angular separations.

The measured quantity is the differential cross section in $\Delta R(BB)$ bins that is compared to LO and NLO predictions. The result is shown in fig. 1 from which it is clear that none of the two MC can describe the trend of the data in the full ΔR range.

Further studies are needed to shed light on this.

REFERENCES

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[3] THE CMS COLLABORATION, *CMS-EWK-11-015*.