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CMS measures diboson production in final states with b-tagged jets

in pp collisions at $\sqrt{s} = 8$ TeV

by Philipp Eller

CERN/Geneva – Measurements are reported of the WZ and ZZ production cross sections in proton-proton collisions at $\sqrt{s} = 8$ TeV in final states where one Z boson decays to b-tagged jets. The other gauge boson, either W or Z, is detected through its leptonic decay. The results are based on data corresponding to an integrated luminosity of 18.9 fb−1 collected with the CMS detector at the Large Hadron Collider.

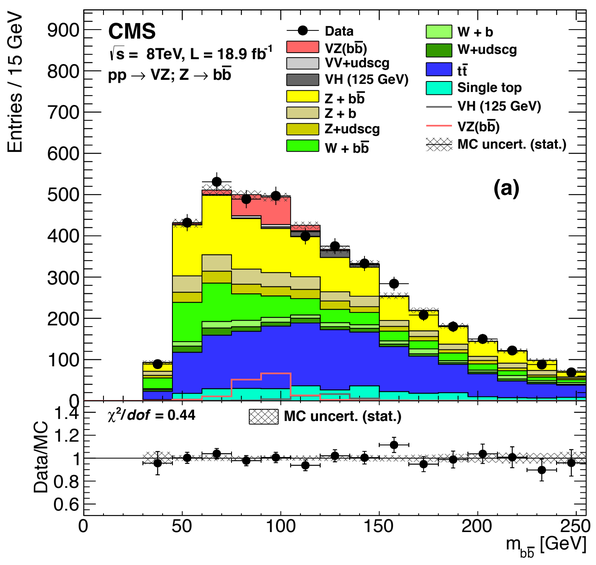
The Analysis

Details and Insights

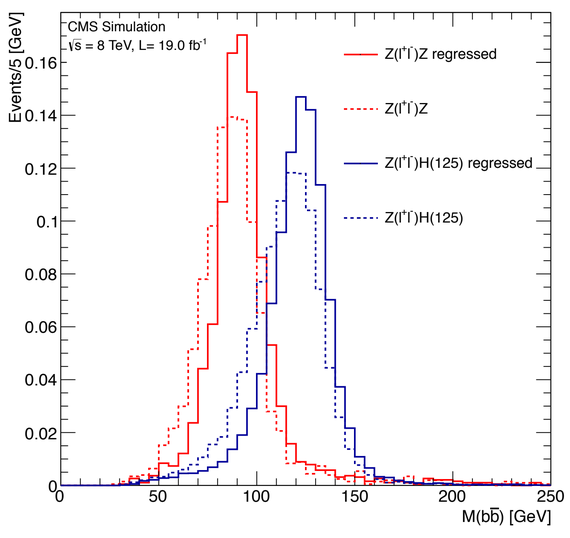
The Measurement presented here is a spin-off of the CMS analysis of the associated Higgs production, where the Higgs decays into b-quarks (1) and employs the same techniques.

Events are categorised depending on the leptonic decay of the W or Z boson (either W → eν, μν or Z → e+e−, μ+μ−, or νν) and its transverse momentum.

One key feature is the regression that is used to better estimate the true b-energy, improving the di-jet mass resolution up to 15%. This technique employs a boosted decision tree (BDT) using jet properties as inputs to assign a corretion to the jet energy. The improvement is illustrated in the figure.

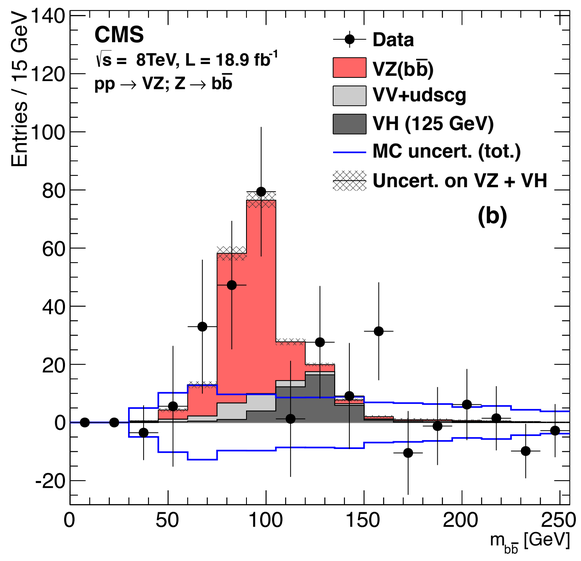


The combined di-jet invariant mass distribution for all channels, compared to MC simulation of SM contributions.

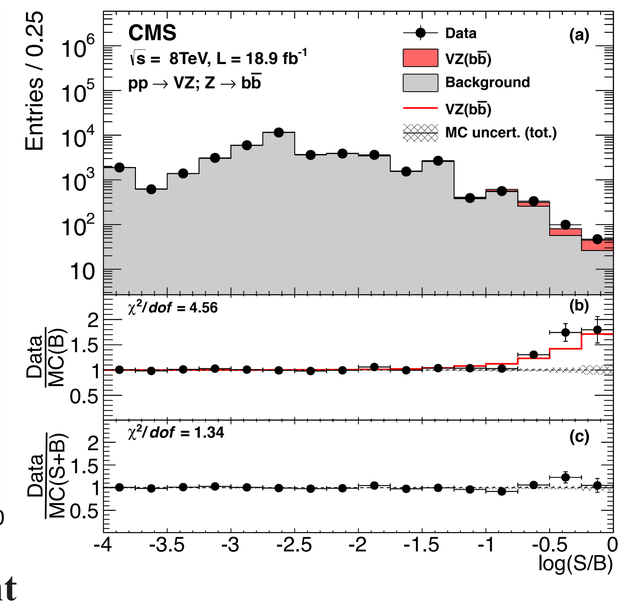


Regressed vs. non-regressed mass of the di-jet system from the Z decay (red) and the H decay (blue) for the analysis in (1)

The major background processes tt-bar and drell-yan + light and heavy flavoured jets are normalized to data in mass sidebands. The other backgrounds from single top production and associated higgs production are normalized to theory calculations. Most important systematic uncertainties are treated either as scale uncertanties, i.e. luminosity (3%), lepton efficiencies and trigger (2%) and background normalizations (2-13%), or they are taken into account as shape variations for jet energy scale (7%) and resolution (6%), b-tagging (7%), MC statistics and modeling (both 5%).



The combined bb invariant mass distribution for all channels, compared to MC simulation of SM contributions with all backgrounds to VZ production, except for the VH contribution, subtracted.



Combined distribution of the BDT output for all channels sorted in bins of signal to background ratios in data and in Monte Carlo (MC) simulations

~ RESULTS ~

Signal extraction is performed by two different methods: a Multivariate technique using a BDT to best separate signal from background and a more direct analysis on the invariant mass spectrum of the di-jet system. Following the numbers based on the BDT are given.

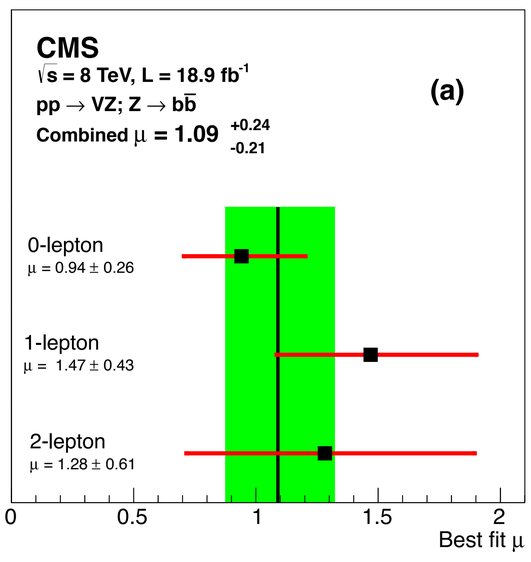
The measured cross sections for both processes are

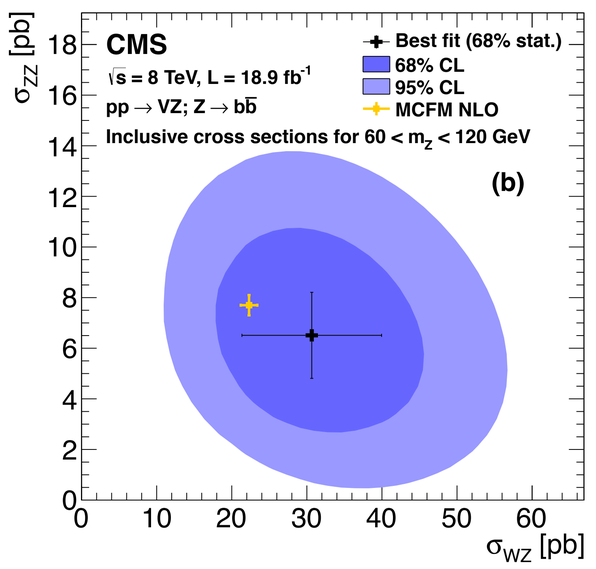
$\sigma_{pp \to WZ} = 30.7 \pm 9.3\ (stat.) \pm 7.1\ (syst.) \pm 4.1\ (th.) \pm 1.0\ (lum.)$ pb

$\sigma_{pp \to ZZ} = 6.5 \pm 1.7\ (stat.) \pm 1.0\ (syst.) \pm 0.9\ (th.) \pm 0.2\ (lum.)$ pb

and are consistent with SM NLO QCD calculations.

Signal strength values for VZ production are consistent among all three event categories (0,1 and 2 lepton channels) and consistent with SM predictions.





(a) **Best-fit values** of the ratios of the VZ production cross sections, relative to SM predictions for individual channels, and for all channels combined (hatched band). (b) **Contours** of 68% and 95% confidence level for WZ and ZZ production cross sections.

1: Phys. Rev. D 89, 012003