Search for Hadronic Resonances at CMS

Sertac Ozturk on behalf of the CMS Collaboration
Gaziosmanpasa University, Department of Physics, 60150 Tokat, TURKEY
At also The University of Iowa, Iowa City, IA 52242-1479 USA

1 Introduction

We present the results of searches for new heavy resonances in dijet, $t\bar{t}$, and multijet hadronic final states in the pp collisions at 7 TeV delivered by LHC and collected with the CMS detector [1] in 2010. No excess of events above the standard model predictions has been found.

2 Dijet Final State

2.1 Dijet Resonance

A search for narrow resonances in the dijet mass spectrum is performed using 2010 data corresponding to an integrated luminosity of 2.9 pb^{-1}. The events which have at least two jets were selected. Jets were reconstructed using the anti-kt algorithm [2] with cone size $R = 0.7$. Both leading jets were required to satisfy the η cuts which are $|\eta_1, \eta_2| < 2.5$ and $|\Delta\eta| < 1.3$. Three generic shapes are considered and simulated for each type of parton pair in the resonance decay (quark-quark (qq), quark-gluon (qg) and gluon-gluon (gg)). These resonance shapes are approximately valid for any resonance model because the natural half-width ($\Gamma/2$) of models is small compared to the dijet mass resolution.

The differential cross section of excited quark signals and string resonance signals as a function of dijet mass on data with QCD MC prediction and smooth fit are shown in the middle plot on Figure 1. The parametrization of smooth fit function chosen is $\frac{d\sigma}{dm} = p_0 \frac{(1-X)^{p_1}}{X^{p_2+p_3 \ln(X)}}$, where $X = m/\sqrt{s}$ and $p_{0,1,2,3}$ are free parameters [3]. The measured dijet mass spectrum is in good agreement with a QCD prediction and there is no evidence for dijet resonances on data.

A Bayesian formalism with a flat prior is used to set 95% confidence-level (CL) upper limits on the resonance production cross section. In the right plot on Figure 1, we compare these upper limits to the model predictions as a function of resonance mass. It is excluded at 95% CL string resonances in the mass range $0.50 < M(S) < 2.50$ TeV, excited quarks in the mass range $0.50 < M(q^*) < 1.58$ TeV, axigluons and

colorons in the mass ranges $0.50 < M(A) < 1.17$ TeV and $1.47 < M(A) < 1.52$ TeV, and E_6 diquarks in the mass ranges $0.50 < M(D) < 0.58$ TeV, $0.97 < M(D) < 1.08$ TeV, and $1.45 < M(D) < 1.60$ TeV. More information is available in [4].

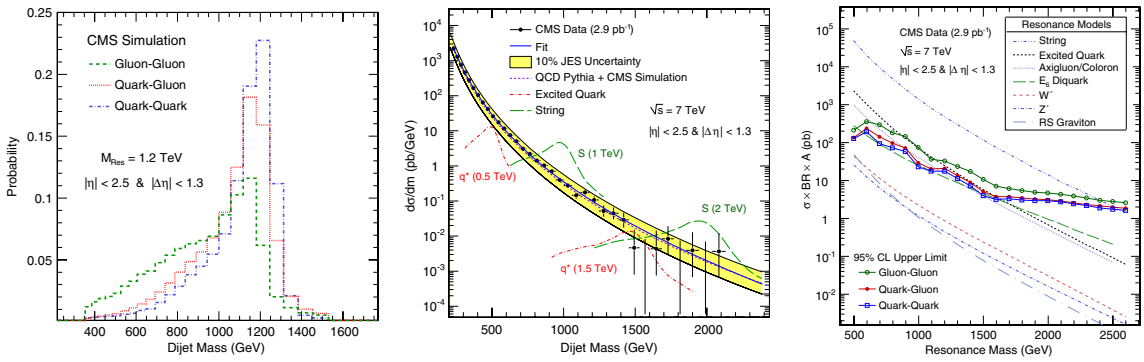

Figure 1: Left: Dijet mass distribution for qq, qg and gg resonance at mass of 1.2 TeV. Middle: The dijet mass distribution compared to a smooth background fit, to a QCD PYTHIA prediction, to simulated narrow resonances. Right: The 95% CL upper limit on cross section times branching ratio and acceptance for qq, qg and gg resonances.

2.2 Dijet Angular Distributions

We present the first measurement of dijet angular distributions from CMS in pp collisions at $\sqrt{s} = 7$ TeV, using data corresponding to an integrated luminosity of 36 pb^{-1}. Jets were reconstructed offline from energies measured in the calorimeter towers using the anti-kt algorithm with cone size $R = 0.5$. Events having at least two jets were selected and the two highest p_T jets were used to measure the dijet angular distributions for different ranges in M_{jj}. We require $\chi_{dijet} = exp(y_1 - y_2) < 16$ and $|y_{boost}| = \frac{1}{2}(y_1 + y_2) < 1.11$, thus restricting the rapidities y_1 and y_2 of the two highest-p_T jets to be less than 2.5. Nine dijet mass analysis ranges are defined.

The dijet angular distributions are corrected in χ_{dijet} and M_{jj} due to the finite jet energy and position resolutions of the detector. Non-perturbative corrections due to hadronization and multiple parton interaction are applied to the prediction. The corrected differential dijet angular distributions for different M_{jj} ranges, normalized to their respective integrals, are shown in the left plot on Figure 2. The data are in good agreement with the predictions of perturbative QCD and yield no evidence of quark compositeness.

A modified frequentist approach is used to set limits on Λ. Limit on the contact interaction scale for left-handed quarks of $\Lambda^+ = 5.6$ TeV ($\Lambda^- = 6.7$ TeV) for

destructive (constructive) interference is obtained at the 95% confidence level. More information can be seen in [5].

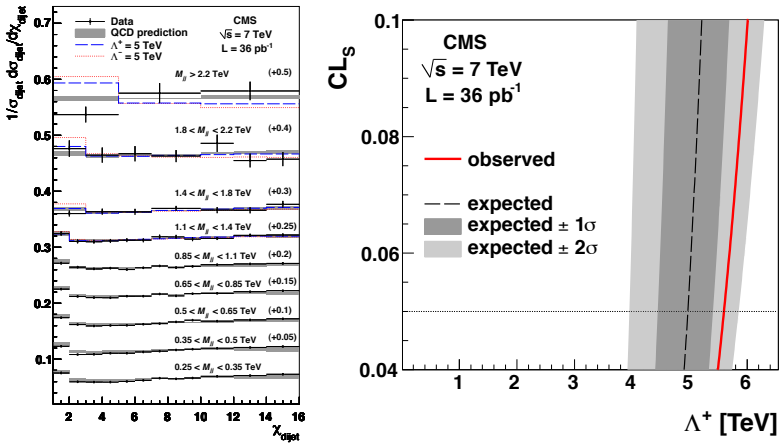

Figure 2: Left: Normalized dijet angular distributions in several Mjj ranges with the predictions of pQCD at NLO and contact interaction term of compositeness scale $\Lambda = 5$ TeV. Right: Observed CL_s and expected CL_s on Λ^+.

3 Multijet Final State

A model-independent search for three-jet hadronic resonance production in pp collisions at $\sqrt{s} = 7$ TeV is presented using data sample corresponding to an integrated luminosity of 35 pb^{-1}. In particular, we are interested in the process $pp \to QQ \to 3jet + 3jet$ where Q is a heavy resonance, yielding a six-jet final state. Jets were reconstructed with CMS particle-flow algorithm using the anti-kt algorithm with a cone radius 0.5. We require there to be at least six jets in the event whose total scalar sum of jet p_T is at least 425 GeV. Jets are required to have $p_T > 45$ GeV and $|\eta| < 3.0$.

In order to reject the background jet triplets, we require each jet triplet to satisfy the relation of $M_{jjj} < \sum_{i=1}^{3} |p_T^{jet}|_i - \Delta$, where M_{jjj} is the triplet invariant mass and Δ is an adjustable offset to optimize the signal to the background. The value for Δ is taken as 130 GeV for all gluino masses considered. The data are in good agreement with expected QCD background and there is no evidence of heavy multijet resonances.

A Bayesian approach is used in setting upper limits on the cross section for multi jet resonances. The expected and observed limits as a function of mass are shown in Figure 3. Excluded mass limit of R-parity violating (RPV) gluino at 95% CL is found between 200 GeV and 280 GeV. The limits from this search are the highest on

gluino production in the RPV scenario to date, and represent the first limits from pp collisions. More information is available in [6].

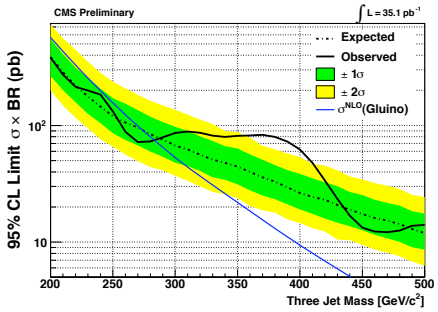

Figure 3: Expected and observed cross section limits at 95% CL.

4 $t\bar{t}$ Final States

The massive neutral bosons search decaying via a top-antitop quark pair based on an integrated luminosity of 36 pb^{-1} in pp collisions at $\sqrt{s} = 7$ TeV is presented here. There is a good agreement with Standard Model (SM) and no significant excess of events above SM expectations is observed. A Bayesian formalism with a flat prior is used to set 95% CL upper limits on the resonance production cross section. Limits of the order of 25 pb for invariant masses in the region of $m_{Z'} = 0.5$ TeV, 7 pb for $m_{Z'} = 1$ TeV and 4 pb for $m_{Z'} > 1.5$ TeV are set, consistent with those expected. These limits are competitive with those from the Tevatron, particularly at higher masses. More information can be seen in [7].

References

[1] CMS Collaboration, JINST **3** S08004 (2008).

[2] M. Cacciari, G. P. Salam, and G. Soyez, JHEP **04** 063 (2008).

[3] CDF Collaboration, Phys. Rev. **D79** 112002 (2009).

[4] CMS Collaboration, Phys. Rev. Lett. **105** 211801(2010).

[5] Phys. Rev. Lett. **106** 201804 (2011).

[6] CMS Collaboration, Phys. Rev. Lett. **107** 101801 (2011).

[7] CMS Collaboration, PAS TOP-10-007 (2010).