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Search for leptoquark-like signatures with the ATLAS and CMS detectors

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Abstract

The most recent results from searches of leptoquark-like signatures are presented using 1.03 and 4.7 fb^{-1} of pp collision data collected by the ATLAS detector with $\sqrt{s}$ = 7 TeV and 19.6 fb^{-1} of pp collision data collected by the CMS detector with $\sqrt{s}$ = 8 TeV at the LHC. First- and second-generation scalar leptoquarks are looked for in the final states with either two leptons and two jets ($\ell\ell + jj,\ \ell = e, \mu$) or one lepton, missing transverse energy, and two jets ($\ell\nu + jj,\ \ell = e, \mu$). Apart from leptoquark investigations, the $\ell\ell + jj$ final states are further studied in a search for W bosons with right-handed couplings that arise in left-right models. Third-generation scalar leptoquarks are looked for in the final state with two tau leptons and two b quarks or two top quarks ($\tau\tau + bb$ and $\tau\tau + tt$). The $\tau\tau + bb$ final state is also sensitive to stop pairs decaying through R-parity violating and conserving processes that are foreseen in some models of supersymmetry. In addition, results are shown for third-generation scalar leptoquarks in the final states $bb + \nu\nu$ and $tt + \nu\nu$, reinterpreting searches for bottom and top squark pair production. 95% confidence level upper limits are set on the scalar leptoquark pair production cross section times branching fraction in each decay channel as a function of the leptoquark mass and the branching ratio of decay.

Keywords: Exotica, ATLAS and CMS collaborations, LHC

1. Introduction

The "leptoquark" (LQ) are hypothetical particles that carry both lepton and baryon number. They are predicted in many extensions of the standard model (SM) of which grand unified theories (GUT) [1], composite models [2], extended technicolor models [3], and superstring-inspired models [4] are some examples. They are SU(3) color-triplet bosons with different properties (spin, weak isospin, electric charge, chirality of the fermion couplings, and fermion number) depending on the structure of each specific model. For this reason direct searches for leptoquarks at collider experiments are typically performed in the context of an effective leptoquark model: the Buchmüller-Rückl-Wyler (BRW) model [5].

This model provides a general effective lagrangian describing interactions of leptoquarks with SM fermions, through a Yukawa coupling generically represented by λ, and naturally accounts for the symmetry between leptons and quarks of the SM. Specific properties are required: (a) leptoquarks need to have dimensionless couplings to SM lepton-quark pairs in order for their interactions to be renormalisable; (b) leptoquark interactions are required to be invariant under the Standard Model $SU(3)_C \times SU(2)_L \times U(1)_Y$ gauge groups; (c) leptoquark interactions with lepton-quark pairs are required to preserve baryon and lepton number separately, to avoid inducing rapid proton decay [6]; (d) leptoquarks couple to a single chirality and generation of SM fermions at a time, in order to suppress flavor-changing neutral currents (FCNCs) [7]. From the previous properties three generations of leptoquarks arise in accordance with the SM nomenclature.

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Leptoquark production can be categorised according to the spin. Scalar leptoquarks have their coupling with gluons determined by the gauge symmetries of quantum chromodynamics (QCD) and their production cross section depends only on the leptoquark mass. Vector leptoquarks are expected to have their couplings to gauge bosons specified by two parameters k_A and λ_A, where A = γ, g, $W^{\pm}$, or Z [8]. The production cross section is generally larger for vector leptoquarks, but the interpretation of the results would be more difficult. Moreover, production cross section for scalar leptoquarks is known at next-to-leading order [9], while for vector leptoquarks only at leading order [8]. Scalar leptoquarks are searched for in the measurements summarised below.

Leptoquarks can be directly produced either singly or in pairs. Single leptoquark production in association with a lepton proceeds through quark-gluon scattering and depends on the unknown Yukawa coupling λ. These interactions are negligible due to the small relative value of λ suggested by stringent bounds from low-energy precision experiments for leptoquark masses $M_{LQ} < 1$ TeV [10]. Pair-production occurs mostly via the strong interaction through gg fusion processes, which dominates, and $q\bar{q}$ annihilation that becomes increasingly important ($\sim 30\%$ of the total cross section at $M_{LQ} = 1.5$ TeV). The pair production mechanism is considered in the following.

Leptoquarks can decay either to a charged lepton and a quark ($LQ \rightarrow \ell q$) or to a neutrino and a quark ($LQ \rightarrow \nu q$). It is customary to denote the branching ratio $\mathcal{B}(LQ \rightarrow \ell q)$ as β and to generally assume that the branching ratio $\mathcal{B}(LQ \rightarrow \nu q)$ is 1-β, where β is unknown in the most general case. Assuming the Yukawa coupling to be sufficiently large to allow prompt leptoquark decay, there are three possible decay modes for a pair of leptoquarks of a given generation: $qq + \{\ell\ell, \ell\nu, \nu\nu\}$ with branching ratios of β^2, 2β(1-β), $(1-\beta^2)^2$. These processes are maximally produced for β = 1, 0.5, and 0 respectively that are the values required in the BRW model.

In this proceeding the most recent results of searches for leptoquark-like signatures are presented using 1.03 and 4.7 fb^{-1} of pp collision data collected by the ATLAS detector [11] with $\sqrt{s}$ = 7 TeV and 19.6 fb^{-1} of pp collision data collected by the CMS detector [12] with $\sqrt{s}$ = 8 TeV at the LHC. Owing to the three generations of leptoquarks and their branching ratio in terms of β, the final states in Table 1 are studied in searches for leptoquark-like signatures. High-p_{T} leptons and jets are expected in these final states and the variable $S_{\mathrm{T}}^{\ell\ell jj(\ell\nu jj)} = p_{\mathrm{T}}^{\ell_1} + p_{\mathrm{T}}^{\ell_2}(E_T) + p_{\mathrm{T}}^{j_1} + p_{\mathrm{T}}^{j_2}$ is widely used in order to discriminate signal from SM background. A complete description of the objects used in the analyses described below can be found in the corresponding references.

Table 1: Final states analysed in searches for new physics with leptoquark-like signature. The table is organised with respect to the three generations of leptoquarks and their branching ratio of decay β.

	β^2	$2\beta(1-\beta)$	$(1-\beta)^2$
1st gen	$ee + jj$	$e\nu + jj$	n/a
2nd gen	$\mu\mu + jj$	$\mu\nu + jj$	n/a
3rd gen	$\tau\tau$+bb,tt	n/a	$\nu\nu$+bb,tt

2. Searches for first- and second-generation leptoquark-like signatures

In this section searches for scalar leptoquarks of the first and the second generation are summarised. Results are shown for measurements by the ATLAS collaboration using 1.03 fb^{-1} of data collected in pp collisions at $\sqrt{s}$ = 7 TeV and by the CMS collaboration using 19.6 fb^{-1} of data collected in pp collisions at $\sqrt{s}$ = 8 TeV. A complete description is given in [14, 15] and [16, 17] respectively. Apart from leptoquark investigations, the signature with two leptons and two jets is further studied by the CMS collaboration in a search for W bosons with right-handed couplings that arise in left-right models. This measurement, performed using 19.6 fb^{-1} of data collected in pp collisions at $\sqrt{s}$ = 8 TeV, is detailed in [18].

2.1. First- and second-generation leptoquarks in Atlas

Events are selected requiring two leptons ($\ell = e, \mu$) with $p_{\mathrm{T}} > 30$ GeV, $|\eta| < 2.5$ and two jets with $p_{\mathrm{T}} >$ 30 GeV, $|\eta| < 2.8$. In the $\ell\ell jj$ topology two leptons, two jets, and the invariant mass $m_{\ell\ell} > 40$ GeV are required. In the $\ell\nu jj$ topology one lepton, $\not{E}_T > 30$ GeV, and $m_T(\ell, \not{E}_T) > 40$ GeV are demanded. $m_T(\ell, \not{E}_T)$ is the transverse mass of the lepton and the $\overrightarrow{\not{E}_T}$ defined as $m_T(\ell, \not{E}_T) = \sqrt{2 \cdot p_T^{\ell}\, \not{E}_T(1 - cos\Delta\phi)}$, where $\Delta\phi$ is the angle between $\overrightarrow{p_{\mathrm{T}}}^{\ell}$ and $\overrightarrow{\not{E}_T}$.

Major backgrounds arise from V+jets (V = Z, W) and $t\bar{t}$ processes. The shape for these background predictions is verified using some control regions that are also used to derive the final normalisation of the backgrounds. Two control regions are used in the $\ell\ell + jj$ channels: $81 < m_{\ell\ell} < 101$ GeV plus at least two jets (for Z+jets); exactly one electron and one muon plus at least two jets (for $t\bar{t}$). Three control regions are used in the $\ell\nu + jj$ channels: $40 < m_T < 120$ GeV, $S_{\mathrm{T}} < 225$ GeV and exactly 2, 3 jets (for W+2, 3 jets); at least 4 jets with $p_{\mathrm{T}} > 40$ GeV (for $t\bar{t}$).

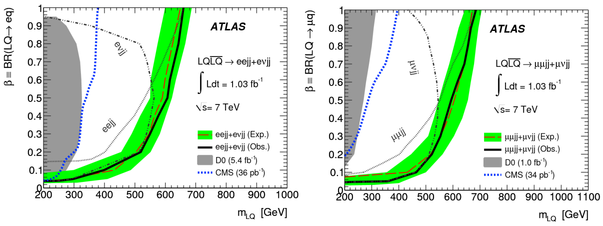

Figure 1: 95% CL exclusion region resulting from the combination of $\ell\ell jj$ and $\ell\nu jj$ (ℓ = e,μ) final states shown in the β-M_{LQ} plane in searches for first (left) and second (right) generation scalar leptoquarks with the ATLAS collaboration.

No excess of events compared to the SM estimations is observed in the signal region. 95% confidence level (CL) upper bounds on the scalar leptoquark pair production cross section times branching ratio of decay in the $\ell\ell jj$, $\ell\nu jj$ channels are determined. Exclusion limits are measured taking into account all the systematics described in [14, 15]. Leptoquarks are excluded for masses M_{LQ} < 660 (685) GeV in the $ee(\mu\mu)jj$ channels assuming $\beta = 1$ and M_{LQ} < 570 (545) GeV in the $e\nu_e(\mu\nu_\mu)jj$ channels assuming $\beta = 0.5$. The exclusion region resulting from the combination of $\ell\ell jj$ and $\ell\nu jj$ final states in the β-M_{LQ} plane is shown in Fig. 1.

2.2. First- and second-generation leptoquarks in CMS

Events are selected requiring two leptons ($\ell = e,\mu$) with $p_{\rm T} > 45$ GeV, $|\eta| < 2.5$ and two jets with $p_{\rm T} > 125$ and 25 GeV, $|\eta| < 2.4$. In the $\ell\ell jj$ topology two leptons, two jets, the invariant mass $m_{\ell\ell} > 50$ GeV, and $S_{\rm T} > 300$ GeV are required. In the $\ell\nu jj$ topology one lepton, $\not{E}_T >$ 55 GeV, and $m_T(\ell, \not{E}_T) > 40$ GeV are demanded. Events with additional leptons are rejected. Requirements on $m_{\ell\ell}$, $S_{\rm T}$ are further optimised together with cuts on the minimum (average) electron-jet invariant mass of the two leptoquark candidates, $m^{min}_{\ell j}(m^{average}_{\ell j})$, considering different leptoquark mass hypotheses and maximising $S/\sqrt{S+B}$, where S (B) represents the number of signal (background) events passing a given selection.

In the $\ell\ell + jj$ final states, Z+jets and $t\bar{t}$ are the main backgrounds. The Z+jets Monte-Carlo (MC) events are rescaled to agree with data in the Z-enriched region within $80 < M_{\ell\ell} < 100$ GeV. The contribution from $t\bar{t}$ is estimated with a $t\bar{t}$-enriched data sample in which an electron and a muon are required and events are reweighted to account for different branching ratios of $\ell\ell$ and $e\mu$ final states and different acceptances of lepton selection. In the $\ell\nu + jj$ final states, W+jets and $t\bar{t}$ processes dominate. Their contributions are determined using MC simulation that has been normalised to data within complementary control regions with 70 $< m_T(\ell, \nu_\ell) <$ 110 GeV and less or at least four jets.

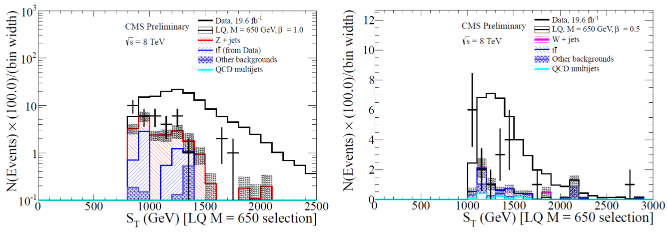

Figure 2: The $S_{\rm T}$ distributions for events passing the $eejj$ (left) and $e\nu jj$ (right) selections optimised for M_{LQ} = 650 GeV in searches for first-generation scalar leptoquarks with the CMS collaboration. The grey bands represent the statistical and systematic uncertainty on the background prediction.

In the $eejj$ and $e\nu_e jj$ channels a broad excess of data compared to the SM expectations is visible for all the selections optimised for a leptoquark of mass greater than 300 GeV. The excess is most significant in the selection optimised for a leptoquark of mass 650 GeV. In the $eejj$ final state 20.5 ± 2.1 (stat.) ± 2.5 (syst.) events are expected and 36 events are observed with a significance of the data with respect to the background estimate of 2.4. In the $e\nu_e jj$ final state 7.5 ±1.2 (stat.) ±1.1 (syst.) events are expected and 18 events are observed with a significance of the data with respect to the background estimate of 2.6. Distributions of $S_{\rm T}$ are shown in Fig. 2. Unlike predicted by the leptoquark signal topology, the excess does not peak sharply in the $m^{min}_{\ell j}$ distribution. It is worth mentioning that good agreement between data and SM expectations is instead observed before optimising the requirements on $m_{\ell\ell}$, $S_{\rm T}$, $m^{min}_{\ell j}$, ($m^{average}_{\ell j}$).

No excess of events is instead observed comparing data to SM expectations in the $\mu\mu jj$ and $\mu\nu_\mu jj$ channels.

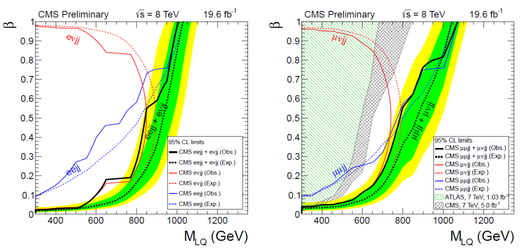

Figure 3: 95% CL exclusion region resulting from the combination of $\ell\ell jj$ and $\ell\nu jj$ (ℓ = e,μ) final states shown in the β-M_{LQ} plane in searches for first (left) and second (right) generation scalar leptoquarks with the CMS collaboration.

95% CL upper bounds on the scalar leptoquark pair production cross section times branching ratio of decay in the $\ell\ell jj$, $\ell\nu jj$ channels are determined. Exclusion limits are measured taking into account all the systematics described in [16, 17]. Leptoquarks are excluded for masses M_{LQ} < 1005 (1070) GeV in the $ee(\mu\mu)jj$ channels assuming $\beta = 1$ and $M_{LQ} < 845$ (740) GeV in the $e\nu_e(\mu\nu_\mu)jj$ channels assuming $\beta = 0.5$. The exclusion region resulting from the combination of $\ell\ell jj$ and $\ell\nu jj$ final states in the β-M_{LQ} plane is shown in Fig. 3. This figure shows that a leptoquark of mass 650 GeV with $\beta < 0.15$ cannot be excluded in the analyses with the electron. This region of the parameter space is dominated by the $e\nu_e jj$ channel. The approximately 10 event excess in the $e\nu_e jj$ final selection optimised for a leptoquark of mass 650 GeV corresponds to a leptoquark of mass 650 GeV and $\beta = 0.075$.

2.3. *W_R bosons with right-handed couplings in CMS*

Events are selected requiring two leptons ($\ell = e, \mu$) with $p_T > 60$ and 40 GeV, $|\eta| < 2.5$ and two jets with $p_T > 40$ GeV, $|\eta| < 2.5$. $M_{\ell\ell} > 200$ GeV is demanded in order to suppress DY + jets background. The four-object mass distribution $M_{\ell\ell jj}$ is used to search for evidence of W_R boson production, considering events in which $M_{\ell\ell jj} > 600$ GeV. A shape-based analysis is performed. The main backgrounds (DY + jets and $t\bar{t}$) are estimated with techniques similar to the ones described in Section 2.2. Results for the mass distribution $M_{\ell\ell jj}$ in the signal region are shown in Fig. 4 (left and middle plots).

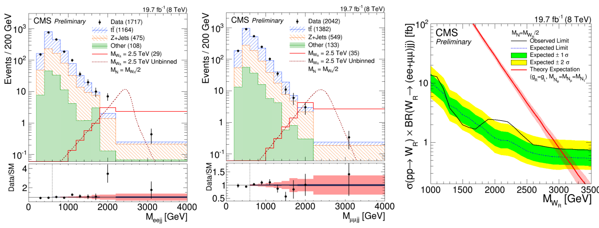

Figure 4: The $M_{\ell\ell jj}$ distributions in searches for W_R bosons in the context of LRSM with the CMS collaboration for the $eejj$ channel (left) and $\mu\mu jj$ channel (middle). On the right, the 95% CL exclusion region resulting from the combination of the two final states is shown.

An excess of events in the electron channel with 1.8 $< M_{eejj} < 2.2$ TeV and a local significance of 2.5 sigma at $M_{eejj} \approx 2.1$ TeV is observed. This excess does not appear to be consistent with a W_R hypothesis, as no localised excess in other distributions associated with these events is found.

The excesses in the final states $eejj$, $e\nu_e jj$ in searches for first-generation leptoquarks and W_R bosons of LRSM refer to different events. A good agreement between data and SM expectations is found again in the final state $\mu\mu jj$.

95% CL upper bounds on the W_R production cross section times branching ratio of decay in the in the $\ell\ell jj$ channel is determined. Exclusion limits are measured taking into account all the systematics described in [18]. The exclusion limit for the combination of $eejj$ and $\mu\mu jj$ channels is shown in Fig. 4 (right). W_R can be excluded for masses $M_{W_R} < 3.0$ TeV.

3. Searches for third-generation leptoquark-like signatures

In this section searches for scalar leptoquarks of the third generation are summarised. Results are shown for measurements by the ATLAS collaboration using 4.7 fb^{-1} of data collected in pp collisions at $\sqrt{s} = 7$ TeV and by the CMS collaboration using 19.7 fb^{-1} of data collected in pp collisions at $\sqrt{s} = 8$ TeV. The search for third-generation leptoquarks in the $\tau\tau bb$ final state in CMS is extended by requiring a higher jet multiplicity looking for stop pairs decaying through R-parity violating and conserving processes that are foreseen in some models of supersymmetry [22]. A complete description is given in [19] and [20, 21] respectively. In addition, results are shown for third-generation scalar leptoquarks in the final states $bb + \nu\nu$ and $tt + \nu\nu$, reinterpreting searches for bottom squark pair [24] and top squark pair [23] production performed by the CMS with 19.5 fb^{-1} at $\sqrt{s} = 8$ TeV.

3.1. *Third-generation leptoquarks in $\tau\tau bb$ decay in Atlas*

Events are selected requiring one electron or one muon with $p_T > 25$ and 20 GeV and one hadronic tau (τ_h) candidate with $p_T > 30$ GeV. Opposite-sign charge of the e and μ lepton to τ_h is demanded to look for final states in which tau pairs decay into $e\tau_h$ or $\mu\tau_h$ channels. At least two jets are required with $p_T > 50$ and 25 GeV, of which one tagged as b jet. All the objects have to be within $|\eta| < 2.5$. In addition, $\not{E}_T > 20$ GeV and the visible mass $M(\tau_h, jet) > 90$ GeV are sought.

The main backgrounds considered in this analysis are the production of multi-jets, V+jets (V = Z, W), $t\bar{t}$, and single top quark. The shape for multi-jets background is taken in a region of data where the e and μ lepton has the same sign of charge as the τ_h. The normalisation is obtained in the region where the e and μ leptons are not isolated. V+jets and top backgrounds are taken from MC predictions after normalisation in background-enriched control regions.

Observations are in good agreement with the estimation of the SM backgrounds. 95% CL upper bounds on the scalar leptoquark pair production cross section times branching ratio of decay in the $\tau\tau bb$ channel is determined. Exclusion limits are measured taking into account all the systematics described in [19]. Combining $e\tau_h bb$ and $\mu\tau_h bb$ final states it is possible to exclude third-generation leptoquarks in the $\tau\tau bb$ decay for masses $M_{LQ} < 534$ GeV as shown in Fig. 5.

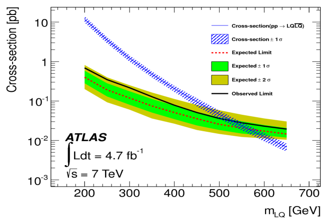

Figure 5: 95% CL exclusion region resulting from the combination of $e\tau_h bb$ and $\mu\tau_h bb$ channels in search for third-generation scalar leptoquarks with the ATLAS collaboration.

3.2. Third-generation leptoquarks in $\tau\tau bb$ decay in CMS

Events are selected requiring one electron or one muon with $p_{\mathrm{T}} > 30$ GeV, $|\eta| < 2.1$ and one hadronic tau (τ_h) candidate with $p_{\mathrm{T}} > 50$ GeV. Opposite-sign charge of the e and μ lepton to τ_h is demanded to look for final states in which taus decay into the $e\tau_h$ or $\mu\tau_h$ channels. At least two jets are required with $p_{\mathrm{T}} > 30$, $|\eta| < 2.4$, of which one tagged as b jet. In addition, the visible mass $M(\tau_h, jet) > 250$ GeV is sought.

The most relevant SM processes that can mimic the signatures expected for the signal are $t\bar{t}$ when both the light lepton and τ_h are produced from decays of genuine τ leptons and $t\bar{t}$, V+jets (V = Z, W) when a jet is misidentified as a hadronically decaying tau. The former irreducible background is estimated from a sample in which an electron, a muon and no τ_h are required. This sample is scaled by the relative difference of the acceptances of lepton selection and the branching ratios between $\ell\tau_h$ and $e\mu$ events. The latter reducible background is estimated by measuring the probability of a jet to be misidentified as a tau in events recorded with a Z boson produced in association with jets and decaying to a pair of muons. This probability is used to weigh events where the τ_h isolation is inverted.

Data agrees with the SM expectations and 95% CL upper bounds on the scalar leptoquark pair production cross section times branching ratio of decay in the $\tau\tau bb$ channel is determined. Exclusion limits are measured taking into account all the systematics described in [20]. Combining $e\tau_h bb$ and $\mu\tau_h bb$ final states it is possible to exclude third-generation leptoquarks in the $\tau\tau bb$ decay for masses $M_{LQ} < 740$ GeV assuming $\beta = 1$. Results are shown in Fig. 6 (green part) in the β-M_{LQ} plane. Results of a search for top squark pair production in pp collisions at $\sqrt{s} = 8$ TeV with 19.5 fb^{-1} [23] where the final state is interpreted in terms of third-generation scalar leptoquarks decaying in $tt\nu\nu$ are also reported (blue part). Extending the analysis described in this section requiring a higher multiplicity of jets (at least five jets) it is also possible to set a limit on the cross section times branching fraction for stop pair production decaying via a mixture of both R-parity conserving and violating couplings (stop decay to a $\tilde{\chi}^{\pm}$ and a b quark, with a subsequent decay of the chargino via $\tilde{\chi}^{\pm} \to \tilde{\nu} + \tau^{\pm} \to jj + \tau^{\pm}$). Stop quarks with masses below 576 GeV are excluded at the 95% CL in this scenario.

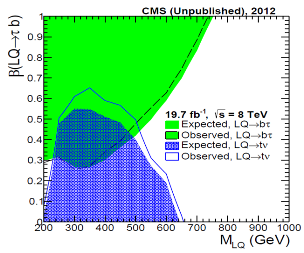

Figure 6: 95% CL exclusion region in the β-M_{LQ} plane resulting from the combination of $e\tau_h bb$ and $\mu\tau_h bb$ channels (green) in searches for third-generation scalar leptoquarks and the $tt\nu\nu$ final state investigated in a search for top-squark pair production (blue) with the CMS collaboration.

3.3. Third-generation leptoquarks in $\tau\tau tt$ decay in CMS

Events are required to have one muon with $p_{\mathrm{T}} > 30$ GeV, $|\eta| < 2.1$ and one τ_h with $p_{\mathrm{T}} > 20$ GeV, $|\eta| < 2.1$. Two complementary categories are defined. Category A requires the same sign of the charge between the muon and the τ_h (the muon coming from the W decayed from the top and the τ_h from the τ expected to decay from the leptoquark, or viceversa), while category B does not have any charge requirements but vetoes events from category A. Both categories demand $S_{\mathrm{T}} > 400$ GeV and at least two jets with $p_{\mathrm{T}} > 30$ GeV, $|\eta| < 2.5$. In category B at least a third jet and $\not{E}_T > 50$ GeV are further sought.

In this analysis signal events are characterised by prompt leptons (from W, Z, τ decay), usually well isolated, and fake leptons (from semi-leptonic heavy-flavor decays or misreconstructed jets), generally not isolated. The analysis in category A utilises a data-driven method to estimate the fake lepton contributions starting from poorly isolated candidates.

Events are organised in four subsets based on the isolation of the reconstructed muon and τ_h. A matrix is introduced to convert events based on the lepton reconstruction into events based on the lepton origin (prompt or fake leptons). The elements of the matrix are related to the probabilities with which prompt and fake leptons pass an isolated or non-isolated lepton selection and are measured in dedicated control regions. The analysis in category B corrects MC events by the fake tau lepton reconstruction rates that is measured in a sample of $W \to \mu\nu + jets$.

In both categories the observed number of events is found to be in overall agreement with the SM background. 95% CL upper bounds on the scalar leptoquark pair production cross section times branching ratio of decay in the $\tau\tau tt$ channel is determined. Exclusion limits are measured taking into account all the systematics described in [21]. Combining results of categories A and B it is possible to exclude third-generation leptoquarks in the $\tau\tau tt$ decay for masses $M_{LQ} < 634$ GeV assuming $\beta = 1$. Results are shown in Fig. 7 (above the line linking the black circles) in the β-M_{LQ} plane. In the figure (below the line linking the dots) are also reported results of a search for bottom squark pair production in pp collisions at $\sqrt{s} = 8$ TeV with 19.4 fb^{-1} [24] where the final state is interpreted in terms of third-generation scalar leptoquarks decaying in $bb\nu\nu$.

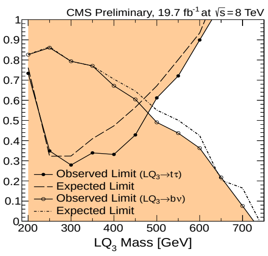

Figure 7: 95% CL exclusion region in the β-M_{LQ} plane resulting from the $\tau\tau tt$ final state in searches for third-generation scalar leptoquarks (above the line linking the black circles) and the $bb\nu\nu$ final state investigated in a search for bottom squark pair production (below the line linking the dots) with the CMS collaboration.

4. Conclusions

Several measurements from ATLAS and CMS at $\sqrt{s}$ = 7 and 8 TeV respectively with different integrated luminosities have been presented in search for new physics beyond the SM looking for leptoquark-like signatures. All three generations of leptoquarks have been considered and almost in all cases there was a good agreement between the observations and the SM expectations. 95% CL upper bounds on the scalar leptoquark pair production cross section times branching ratio of decay are determined in the β-M_{LQ} plane. Exclusion limits under the assumption of the BRW model, for which $\{\ell\ell, \ell\nu, \nu\nu\} + qq$ are maximally produced having $\beta = 1$, 0.5, and 0, are shown in Table 2. A discrepancy between data and SM predictions has been observed in searches for leptoquarks of the first generation in the $eejj$, $e\nu jj$ channels and it has not be possible to exclude masses lower than 650 GeV for $\beta < 0.15$. An independent excess of data compared to the SM expectations is observed in the final state $eejj$ in search for right-handed bosons, W_R, in the LRSM model. A recent article [25] points out that additional leptoquark production from a heavy coloron decay can provide a good explanation for all the three excesses. Leptoquark signature are sensitive to decay of supersymmetric particles and an exclusion limit at 95% CL has been reported for stop quarks with masses below 576 GeV.

Table 2: Summary of exclusion limits for the leptoquark mass with respect to their three generations and decay branching ratios β. The BRW model is considered in the interpretation of the results for which $\{\ell\ell, \ell\nu, \nu\nu\} + qq$ are maximally produced having $\beta = 1$, 0.5, and 0.

	β^2	$2\beta(1-\beta)$	$(1-\beta)^2$
1st gen	<1005 GeV ($ee + jj$)	<845 GeV ($e\nu + jj$)	n/a
2nd gen	<1070 GeV ($\mu\mu + jj$)	<785 GeV ($\mu\nu + jj$)	n/a
3rd gen	<740 GeV ($\tau\tau$+bb) <634 GeV ($\tau\tau$+tt)	n/a	< 724 GeV ($\nu\nu$+bb) < 660 GeV ($\nu\nu$+tt)

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