Searches for new physics in lepton+jets final states

Marc Stöver

on behalf of the CMS collaboration

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Introduction

$\ell + jets$ signature expected in many scenarios beyond SM

this talk: CMS searches

- 1st, 2nd and 3rd generation leptoquarks
- heavy neutrino and $W_R$
- heavy compositeness Majorana neutrinos

Full list of CMS results:
LQ1 and LQ2 in $\ell\ell jj$ final states (2.6 fb$^{-1}$)

Selection
- 2$\ell$ at high $p_T$
- 2jets at high $p_T$
- optimization of $M_{\ell\ell}$, $S_T$ and $M_{\text{min}}(\ell,\text{jet})$ for each signal mass point

BG estimation
- $t\bar{t}$: from simulation, normalized to data in $e\mu$ CR (LQ1), from data $e\mu$ events (LQ2)
- $Z + \text{jets}$: estimated from simulation, normalized to data in Z-peak region
Results for LQ1 and LQ2

Exclusion limits:
- \( M(\text{LQ1}) > 1130 \text{GeV} \)
- \( M(\text{LQ2}) > 1165 \text{GeV} \)
Heavy neutrinos and $W_R$ in $\ell\ell jj$ final state (2.6fb$^{-1}$)

CMS-EXO-16-045

LQ analyses can be interpreted in left-right handed SM

Selection

- $2\ell$ at high $p_T$
- 2jets at high $p_T$
- requirements on $M_{\ell\ell}$ and $M_{\ell\ell jj}$

BG estimation

- $t\bar{t}$: from data in $e\mu$ CR extrapolated to SR
- $Z + jets$: estimated from simulation normalized data in $Z$-peak region
- Others taken from simulation
Searches with 2 taus and 2 jets (2.1fb\(^{-1}\))

**Selection**
- 2\(\tau_h\) at high \(p_T\)
- 2jets at high \(p_T\)
- requirements on \(E_T\) and \(M_{\tau\tau}\)

**BG estimation**
- QCD: data-driven ABCD method (\(E_T\), isolation of \(\tau_h\))
- Others from simulation

![diagram](image-url)
Results on $W_R/LQ3$: $\tau_h\tau_h bb$

- limit $LQ3 > 740$ GeV
- limit $W_R > 2.31$ TeV for $M(N_\tau) = 0.5M(W_R)$
**W_R/LQ3: \( \tau_h \ell b b \) (12.9 fb\(^{-1} \))**

**Selection**
- \( 1\tau_h, 1\ell, \) OS charge
- \( n_{\text{jets}} \geq 2, \) at least one b-tag
- requirements on \( M(\tau_h, j), E_T \) and \( M(\tau_h, \ell) \)

**BG estimation**
- \( t\bar{t} \): from simulation, validated in \( e\mu \) data sample
- \( W + \text{jets} \): from simulation, normalization from CR

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**Graphs**
- CMS Observed vs. LQ 900 GeV, \( \mu \tau_h \)
- CMS Observed vs. LQ 900 GeV, \( e \tau_h \)
- Obs./Exp. vs. \( S_T \) [GeV] for both graphs

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Results on $W_R$/LQ3: $\tau_h\ell bb$

- limit $W_R > 2.9\text{TeV}$ for $M(N_T) = 0.5M(W_R)$
- limit $LQ3 > 850\text{GeV}$ for $\beta = 1$
Heavy compositeness Majorana neutrinos in $\ell\ell jj$ final state (2.3fb$^{-1}$)


Selection

- $2\ell$ at high $p_T$
- 1 large radius jet at high $p_T$
- $M_{\ell\ell} > 300$GeV

BG estimation

- $t\bar{t}$: from $e\mu$ CR in data
- $Z + jets$: from simulation, normalized to data in $Z$ peak region
- Others taken from simulation

CMS Preliminary

$\mu\mu J$

$2.3 fb^{-1}$ (13 TeV)

Events vs $M(\mu\mu J)$ (GeV)

Observed $\sigma$ $\pm$ Expected $\sigma$

$\nu_t$ vs $N$ mass (TeV)

$\sigma(pp \rightarrow \nu_t N \rightarrow \mu\mu J)$ (pb)

Theory uncertainty

$\Lambda$ (13 TeV)$^{-1}$ 2.3 fb$^{-1}$ CMS Preliminary
CMS covers wide program of searches in $\ell + jets$ final states
- Here: leptoquark and heavy neutrino searches
- No significant excess found above SM predictions
- Limits are set on benchmark models
- Expect results with full 2016 data from all analyses