IL NUOVO CIMENTO Vol. 34 C, N. 6 Novembre-Dicembre 2011
DOI 10.1393/ncc/i2011-11087-4

Colloquia: IFAE 2011

Search for New Physics with same-sign isolated dilepton events with jets and missing transverse energy at LHC

R. Volpe on behalf of the CMS Collaboration

National Central University - Chung-Li, Taiwan

(ricevuto il 29 Luglio 2011; pubblicato online il 21 Dicembre 2011)

Summary. — The results of searches for new physics in events with two same-sign isolated leptons, hadronic jets, and missing transverse energy in the final state are presented. The searches use an integrated luminosity of $35\,\mathrm{pb}^{-1}$ of pp collision data at a centre-of-mass energy of 7 TeV collected by the CMS experiment at the LHC. The observed numbers of events agree with the standard model predictions, and no evidence for new physics is found.

PACS 11.30.Pb – Supersymmetry.

Several New Physics (NP) scenarios foresee the final state with same-sign isolated lepton pairs from hadron collisions [1]. Since such a signature is very rare in Standard Model (SM), it is a very promising way to discover NP. In this search performed with the CMS experiment [2], the events are also required to have a large missing transverse energy ($\vec{\not{E}}_T$), driven by the astrophysical evidence of the presence of Dark Matter, and large hadronic activity (quantified by the variable $H_T = \sum p_T(\text{selected jets})$), since it corresponds to NP signals with larger cross sections. The p_T spectrum of the leptons in the final states, the amount of the hadronic activity and the yield of tau leptons in the final state, could depend on the specific model. Therefore, in order to maximize the sensitivity, four different strategies have been used to cover a large phase space.

A: ee, $e\mu$, $\mu\mu$, single e/μ trigger, $p_T(lep) > 20$, 10 GeV, $H_T > 200\,\mathrm{GeV}$, $\vec{\not{E}}_T > 30\,\mathrm{GeV}$;

B: ee, $e\mu$, $\mu\mu$, single e/μ trigger, $p_T(lep) > 20$, 10 GeV, $H_T > 60\,\mathrm{GeV}$, $\vec{\not{E}}_T > 80\,\mathrm{GeV}$;

C: ee, $e\mu$, $\mu\mu$, H_T trigger, $p_T(e) > 10\,\mathrm{GeV}$, $p_T(\mu) > 5\,\mathrm{GeV}$, $H_T > 300\,\mathrm{GeV}$, $\vec{\not{E}}_T > 30\,\mathrm{GeV}$;

D: $e\tau$, $\mu\tau$, $\tau\tau$, with τs hadronically decaying (τ_h), H_T trigger, $p_T(e) > 10\,\mathrm{GeV}$, $p_T(\mu) > 5\,\mathrm{GeV}$, $p_T(\tau) > 15\,\mathrm{GeV}$, $H_T > 350\,\mathrm{GeV}$, $\vec{\not{E}}_T > 50\,\mathrm{GeV}$.

TABLE I. – *Number of observed events, background prediction, and* 95% *CL upper limit to the event yield.*

Search region		ee	$\mu\mu$	$e\mu$	Total	UL Yield
A	pred. BKG	$0.23^{+0.35}_{-0.23}$	$0.23^{+0.26}_{-0.23}$	0.74 ± 0.55	1.2 ± 0.8	
	observed	0	0	0	0	3.1
B	pred. BKG	0.71 ± 0.58	$0.01^{+0.24}_{-0.01}$	$0.25^{0.27}_{-0.25}$	0.97 ± 0.74	
	observed	0	0	1	1	4.3
C	pred. BKG	0.10 ± 0.07	0.30 ± 0.13	0.40 ± 0.18	0.80 ± 0.31	
	observed	1	0	0	1	4.4
		$e\tau_h$	$\mu\tau_h$	$\tau_h\tau_h$	Total	UL Yield
D	pred. BKG	0.10 ± 0.10	0.17 ± 0.14	0.02 ± 0.01	0.29 ± 0.17	
	observed	0	0	0	0	3.4

By defining *fake* leptons, the leptons coming neither from vector bosons nor from NP particles, the background composition can be classified in: i) two fake leptons, ii) one fake lepton, iii) no fake leptons but opposite sign leptons with a charge mis-measurement and iv) the irreducible background with same sign isolated real leptons from SM. iv) is estimated from MC and assigned an uncertainty of 50% and iii) is estimated by using events selected as $Z \to e^+e^-$. The most important background contributions come from i) and ii) and are estimated by data driven methods. The *fake* leptons can be real leptons from heavy flavor decay, electrons from unidentified photon conversions, muons from meson decays-in-flight, hadrons reconstructed as leptons, or hadronic jets faking to hadronic τ decays. Backgrounds from jets mimicking leptons are estimated using the so-called "Tight-Loose" (TL) method [1], where the probability for a lepton passing loose cuts to also pass the tight analysis cuts, is measured in QCD multi-jet events.

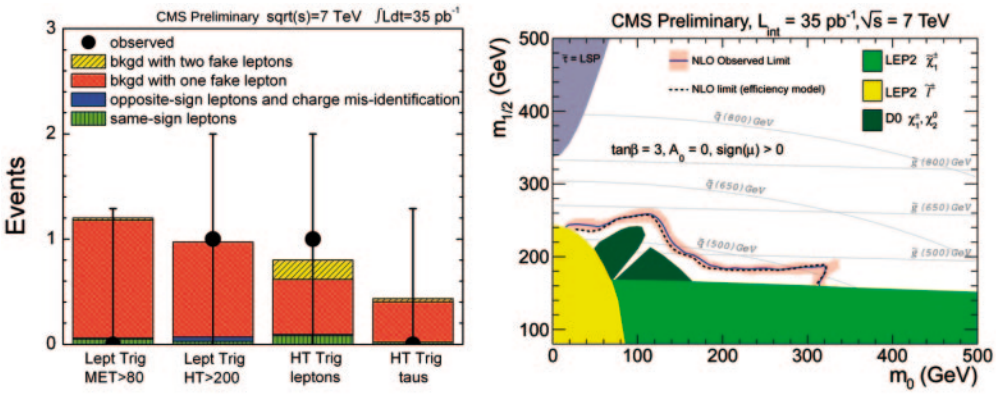

Fig. 1. – Left: estimated background composition compared with the observed event number. Right: upper limit to a Supersymmetry model.

The predicted number of SM events in the four regions are compared with the observed number of events in table I and fig. 1 (left) which shows also the contribution from every source. No excess over SM prediction has been observed, the 95% CL upper limit to NP yield is reported in table I. Efficiency for lepton reconstruction and selection and H_T, $\vec{\not{E}}_T$ resolution (*efficiency model*) are provided [1] in order to allow for testing any theoretical NP model. A model in the Supersymmetry scenario has been used to test them, the good agreement between the limit obtained with the detector simulation and the one obtained with the efficiency model is shown in fig. 1 (right) for the B strategy.

REFERENCES

[1] CMS Collaboration, *JHEP*, **1106** (2011) 077.
[2] CMS Collaboration, *JINST*, **3** (2008) S08004.