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Search for supersymmetry in events with a τ lepton pair and missing transverse momentum in proton-proton collisions at $\sqrt{s} = 13$ TeV

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Abstract: A search for the electroweak production of supersymmetric particles in proton-proton collisions at a center-of-mass energy of 13 TeV is presented in final states with a τ lepton pair. Both hadronic and leptonic decay modes are considered for the τ leptons. Scenarios involving the direct pair production of τ sleptons, or their indirect production via the decays of charginos and neutralinos, are investigated. The data correspond to an integrated luminosity of 35.9 fb^{-1} collected with the CMS detector in 2016. The observed number of events is consistent with the standard model background expectation. The results are interpreted as upper limits on the cross section for τ slepton pair production in different scenarios. The strongest limits are observed in the scenario of a purely left-handed low mass τ slepton decaying to a nearly massless neutralino. Exclusion limits are also set in the context of simplified models of chargino-neutralino and chargino pair production with decays to τ leptons, and range up to 710 and 630 GeV, respectively.

Keywords: Hadron-Hadron scattering (experiments), Supersymmetry

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SR label	$t\bar{t}$	DY+jets	WW+jets	WW+jets	Rest	QCD	Total Bkg	$\widetilde{\chi}_1^{\pm}\ \widetilde{\chi}_2^0$ (400,1)	$\widetilde{\chi}_1^{\pm}\ \widetilde{\chi}_2^0$ (400,175)	$\widetilde{\tau}_L$(90,1)	Observed
0j-1	$2.5 \pm 1.0 \pm 1.6$	<0.1	$0.6 \pm 0.3 \pm 0.4$	$0.6 \pm 0.4^{+0.7}_{-0.6}$	$0.1 \pm 0.1 \pm 0.1$	<0.1	$3.9 \pm 1.1 \pm 1.8$	<0.1	<0.1	<0.1	3
0j-2	$40.0 \pm 3.8 \pm 12.9$	$155.4 \pm 13.5 \pm 20.7$	$21.1 \pm 1.9 \pm 6.0$	$248.7 \pm 7.1 \pm 64.4$	$37.3 \pm 11.6 \pm 22.4$	$35.0 \pm 16.2 \pm 23.8$	$537.5 \pm 25.4 \pm 76.4$	<0.1	<0.1	$0.4 \pm 0.0^{+2.5}_{-0.4}$	584
0j-3	$21.3 \pm 2.8 \pm 7.1$	<0.1	$9.9 \pm 1.3 \pm 3.8$	$47.2 \pm 3.1 \pm 13.3$	$1.6^{+1.6}_{-1.6} \pm 3.9$	$4.3^{+5.1}_{-4.3} \pm 5.5$	$84.2 \pm 6.9 \pm 16.9$	<0.1	<0.1	$0.1 \pm 0.0^{+0.8}_{-0.1}$	105
0j-4	$0.4 \pm 0.4^{+0.8}_{-0.4}$	<0.1	$0.2 \pm 0.2^{+0.6}_{-0.2}$	$0.6 \pm 0.4 \pm 0.6$	$0.0^{+0.0}_{-0.0} \pm 2.3$	<0.1	$1.2 \pm 0.6 \pm 2.5$	<0.1	<0.1	<0.1	2
0j-5	$5.7 \pm 1.4 \pm 2.8$	$2.4 \pm 1.5 \pm 1.6$	$2.9 \pm 0.7 \pm 1.2$	$7.1 \pm 1.2 \pm 2.2$	$1.8 \pm 1.5^{+2.4}_{-1.8}$	<0.1	$20.0 \pm 2.9 \pm 4.8$	<0.1	<0.1	$0.2 \pm 0.0^{+1.2}_{-0.2}$	21
0j-6	$105.3 \pm 6.2 \pm 33.2$	<0.1	$66.2 \pm 3.4 \pm 18.8$	$302.9 \pm 7.8 \pm 79.8$	$16.1 \pm 5.6 \pm 10.7$	$22.6 \pm 11.2 \pm 15.9$	$513.1 \pm 16.4 \pm 90.6$	$0.2 \pm 0.0^{+0.6}_{-0.2}$	<0.1	<0.1	531
0j-7	$82.9 \pm 5.5 \pm 29.4$	$1.4 \pm 1.4^{+1.5}_{-1.4}$	$46.0 \pm 2.8 \pm 13.1$	$424.6 \pm 9.3 \pm 110.0$	$19.9 \pm 6.2 \pm 16.1$	$19.6 \pm 13.8 \pm 16.9$	$594.4 \pm 18.8 \pm 116.9$	$0.1 \pm 0.0^{+0.2}_{-0.1}$	<0.1	$0.3 \pm 0.0^{+1.8}_{-0.3}$	618
0j-8	$2.6 \pm 0.9^{+2.9}_{-2.6}$	<0.1	$0.6 \pm 0.3 \pm 0.6$	$1.9 \pm 0.6 \pm 1.5$	$0.1 \pm 0.1^{+0.2}_{-0.1}$	<0.1	$5.3 \pm 1.1 \pm 3.4$	<0.1	<0.1	<0.1	7
0j-9	$4.9 \pm 1.3 \pm 1.9$	<0.1	$1.6 \pm 0.5 \pm 0.8$	$1.7 \pm 0.6 \pm 1.4$	$0.4 \pm 0.3^{+0.7}_{-0.4}$	<0.1	$8.6 \pm 1.5 \pm 2.6$	<0.1	<0.1	<0.1	12
0j-10	$119.2 \pm 6.5 \pm 33.4$	$28.3 \pm 5.9 \pm 8.0$	$49.7 \pm 2.9 \pm 13.2$	$123.9 \pm 5.0 \pm 36.1$	$10.2 \pm 3.9 \pm 8.8$	$13.0 \pm 10.3 \pm 12.2$	$344.2 \pm 15.2 \pm 53.7$	$0.2 \pm 0.0^{+0.6}_{-0.2}$	<0.4	$0.9 \pm 0.0^{+6.1}_{-0.9}$	324
0j-11	$17.0 \pm 2.5 \pm 6.6$	<0.1	$10.5 \pm 1.3 \pm 3.4$	$21.4 \pm 2.1 \pm 6.3$	$1.6 \pm 1.0^{+3.3}_{-1.6}$	<0.1	$50.7 \pm 3.6 \pm 10.3$	<0.1	<0.1	<0.1	50
0j-12	$129.0 \pm 6.8 \pm 36.9$	$0.5 \pm 0.5 \pm 0.5$	$61.3 \pm 3.2 \pm 16.5$	$224.7 \pm 6.7 \pm 58.9$	$8.2 \pm 3.2 \pm 3.4$	$11.6 \pm 7.9 \pm 9.8$	$435.3 \pm 13.2 \pm 72.2$	$0.2 \pm 0.0^{+0.6}_{-0.2}$	<0.2	$0.4 \pm 0.0^{+2.4}_{-0.4}$	457
0j-13	$27.9 \pm 3.2 \pm 8.8$	<0.1	$10.7 \pm 1.3 \pm 3.7$	$29.2 \pm 2.4 \pm 8.9$	$1.0 \pm 0.2^{+1.5}_{-1.0}$	<0.1	$68.8 \pm 4.2 \pm 13.1$	$0.2 \pm 0.0^{+0.5}_{-0.2}$	<0.1	<0.1	77
0j-14	$4.6 \pm 1.2 \pm 2.1$	<0.1	$1.3 \pm 0.5 \pm 1.1$	$1.8 \pm 0.6 \pm 1.0$	$0.3 \pm 0.3^{+0.5}_{-0.3}$	<0.1	$8.1 \pm 1.5 \pm 2.6$	<0.1	<0.1	<0.1	9
0j-15	$40.2 \pm 3.7 \pm 12.7$	$4.8 \pm 2.3 \pm 2.4$	$14.3 \pm 1.5 \pm 4.0$	$27.8 \pm 2.3 \pm 7.6$	$2.8 \pm 1.4 \pm 1.9$	$0.7^{+4.1}_{-0.7} \pm 4.2$	$90.5 \pm 6.8 \pm 16.2$	$0.2 \pm 0.0^{+0.5}_{-0.2}$	<0.1	$0.2 \pm 0.0^{+1.6}_{-0.2}$	82
0j-16	$18.0 \pm 2.5 \pm 5.6$	<0.1	$8.1 \pm 1.2 \pm 2.8$	$11.4 \pm 1.5 \pm 3.4$	<0.1	$2.9^{+3.4}_{-2.9} \pm 3.7$	$40.5 \pm 4.7 \pm 8.1$	$0.1 \pm 0.0^{+0.2}_{-0.1}$	<0.1	<0.1	51
0j-17	$30.5 \pm 3.2 \pm 10.4$	<0.1	$13.5 \pm 1.5 \pm 4.0$	$15.2 \pm 1.7 \pm 4.9$	<0.1	<0.1	$59.3 \pm 4.0 \pm 12.2$	$0.1 \pm 0.0^{+0.3}_{-0.1}$	<0.2	<0.1	61
0j-18	$9.0 \pm 1.8 \pm 3.7$	<0.1	$2.2 \pm 0.6 \pm 1.0$	$1.1 \pm 0.5^{+1.2}_{-1.1}$	$0.2 \pm 0.1 \pm 0.1$	$1.9^{+1.9}_{-1.9} \pm 2.1$	$14.5 \pm 2.7 \pm 4.5$	<0.1	<0.1	<0.1	11
0j-19	$10.5 \pm 1.9 \pm 3.7$	<0.1	$5.1 \pm 0.9 \pm 1.7$	$8.7 \pm 1.3 \pm 3.2$	$0.6 \pm 0.4 \pm 0.5$	$0.7^{+2.0}_{-0.7} \pm 2.0$	$25.6 \pm 3.2 \pm 5.5$	$0.1 \pm 0.0^{+0.3}_{-0.1}$	<0.2	<0.1	30
0j-20	$1.4 \pm 0.7 \pm 1.0$	<0.1	$0.5 \pm 0.3 \pm 0.5$	$2.8 \pm 0.8 \pm 1.3$	$0.2 \pm 0.1 \pm 0.2$	<0.1	$4.9 \pm 1.1 \pm 1.7$	$0.1 \pm 0.0^{+0.3}_{-0.1}$	<0.1	<0.1	5
0j-21	$0.4 \pm 0.4^{+0.6}_{-0.4}$	<0.1	<0.4	$3.5 \pm 0.8 \pm 1.4$	$0.2 \pm 0.1 \pm 0.1$	$1.6^{+1.9}_{-1.6} \pm 2.1$	$5.6 \pm 2.1 \pm 2.6$	$0.3 \pm 0.0^{+0.6}_{-0.3}$	<0.1	<0.1	4
0j-22	$2.4 \pm 0.9 \pm 1.3$	<0.1	$0.7 \pm 0.3 \pm 0.5$	$0.9 \pm 0.4 \pm 0.5$	<0.1	<0.1	$4.1 \pm 1.0 \pm 1.4$	<0.1	<0.1	<0.1	2
1j-1	$1.0 \pm 0.6^{+1.1}_{-1.0}$	<0.1	$0.2 \pm 0.2^{+0.2}_{-0.2}$	$0.2 \pm 0.2^{+0.8}_{-0.2}$	$1.6 \pm 1.4^{+2.8}_{-1.6}$	$3.6 \pm 2.7 \pm 3.3$	$6.5 \pm 3.2 \pm 4.5$	<0.1	<0.1	<0.1	2
1j-2	$20.2 \pm 2.7 \pm 7.6$	<0.1	$6.3 \pm 1.0 \pm 2.4$	$10.1 \pm 1.4 \pm 3.1$	$1.8 \pm 0.5 \pm 1.0$	$0.3^{+5.3}_{-0.3} \pm 5.3$	$38.6 \pm 6.2 \pm 10.1$	<0.1	<0.1	<0.1	43
1j-3	$138.1 \pm 7.0 \pm 40.1$	$50.5 \pm 6.2 \pm 10.4$	$52.3 \pm 3.0 \pm 15.0$	$114.1 \pm 4.8 \pm 29.6$	$23.0 \pm 7.0 \pm 10.5$	<0.1	$378.0 \pm 13.0 \pm 54.1$	$0.0 \pm 0.0^{+0.2}_{-0.0}$	$0.2 \pm 0.1 \pm 0.1$	$0.2 \pm 0.0^{+1.1}_{-0.2}$	382
1j-4	$121.1 \pm 6.6 \pm 36.9$	$1.2 \pm 0.7 \pm 0.8$	$48.0 \pm 2.9 \pm 13.8$	$59.4 \pm 3.5 \pm 16.6$	$5.7 \pm 2.0 \pm 4.2$	<0.1	$235.3 \pm 8.3 \pm 43.0$	<0.1	$0.1 \pm 0.1 \pm 0.1$	<0.1	211
1j-5	$6.6 \pm 1.5 \pm 3.3$	$0.5 \pm 0.5^{+0.6}_{-0.5}$	$2.2 \pm 0.6 \pm 1.0$	$5.3 \pm 1.0 \pm 2.4$	$0.7 \pm 0.4 \pm 0.7$	$6.6 \pm 4.2 \pm 5.3$	$22.0 \pm 4.7 \pm 6.8$	<0.1	<0.1	<0.1	20
1j-6	$49.3 \pm 4.2 \pm 15.3$	$3.2 \pm 1.8 \pm 1.9$	$9.7 \pm 1.3 \pm 3.3$	$15.9 \pm 1.8 \pm 4.8$	$2.8 \pm 1.1^{+5.0}_{-2.8}$	<0.1	$80.8 \pm 5.2 \pm 17.3$	<0.1	<0.1	$0.0 \pm 0.0^{+0.2}_{-0.0}$	54
1j-7	$266.9 \pm 9.8 \pm 79.3$	$0.5 \pm 0.4 \pm 0.4$	$86.1 \pm 3.8 \pm 23.4$	$165.0 \pm 5.8 \pm 42.5$	$14.2 \pm 4.5 \pm 6.5$	$17.7 \pm 11.7 \pm 14.6$	$550.3 \pm 17.3 \pm 94.3$	$0.3 \pm 0.1^{+0.7}_{-0.3}$	<0.3	$0.1 \pm 0.0^{+0.7}_{-0.1}$	511
1j-8	$35.9 \pm 3.6 \pm 11.5$	<0.1	$6.4 \pm 1.0 \pm 3.0$	$9.4 \pm 1.4 \pm 3.0$	<0.1	<0.1	$51.7 \pm 4.0 \pm 12.3$	$0.1 \pm 0.0^{+0.2}_{-0.1}$	<0.1	<0.1	62
1j-9	$31.5 \pm 3.3 \pm 10.5$	<0.1	$7.1 \pm 1.1 \pm 2.9$	$9.9 \pm 1.4 \pm 3.1$	$0.6 \pm 0.5 \pm 0.6$	$2.0^{+2.8}_{-2.0} \pm 3.0$	$51.1 \pm 4.8 \pm 11.8$	$0.0 \pm 0.0^{+0.2}_{-0.0}$	<0.1	<0.1	40
1j-10	$68.1 \pm 4.9 \pm 21.3$	$0.4 \pm 0.4 \pm 0.4$	$20.7 \pm 1.9 \pm 5.9$	$14.1 \pm 1.7 \pm 4.1$	$1.4^{+1.8}_{-1.4} \pm 2.7$	<0.1	$104.8 \pm 5.8 \pm 22.7$	$0.2 \pm 0.0^{+0.4}_{-0.2}$	<0.1	<0.1	88
1j-11	$93.2 \pm 5.8 \pm 30.3$	<0.1	$28.8 \pm 2.2 \pm 9.0$	$25.8 \pm 2.3 \pm 7.4$	$1.7 \pm 0.7 \pm 1.7$	<0.1	$149.5 \pm 6.6 \pm 32.5$	$0.4 \pm 0.1^{+1.0}_{-0.4}$	$0.4 \pm 0.1 \pm 0.1$	<0.1	122
1j-12	<0.4	<0.1	<0.1	$0.4 \pm 0.3 \pm 0.4$	<0.1	<0.1	$0.5 \pm 0.3 \pm 0.6$	<0.1	<0.1	<0.1	0
1j-13	$2.6 \pm 0.9 \pm 1.2$	<0.1	$1.1 \pm 0.4 \pm 0.5$	$1.5 \pm 0.6 \pm 0.8$	<0.1	<0.1	$5.4 \pm 1.2 \pm 1.6$	<0.1	<0.1	<0.1	1
1j-14	$23.7 \pm 2.8 \pm 7.0$	<0.1	$6.1 \pm 1.0 \pm 2.0$	$6.4 \pm 1.1 \pm 2.1$	$0.3 \pm 0.1 \pm 0.3$	$2.8 \pm 2.8^{+3.1}_{-2.8}$	$39.4 \pm 4.2 \pm 8.2$	$0.1 \pm 0.0^{+0.3}_{-0.1}$	<0.1	<0.1	30
1j-15	$250.0 \pm 9.2 \pm 73.0$	$6.4 \pm 1.8 \pm 3.1$	$48.0 \pm 2.8 \pm 12.8$	$81.0 \pm 4.0 \pm 21.2$	$10.6 \pm 2.4 \pm 7.9$	$3.9^{+7.1}_{-3.9} \pm 7.3$	$399.8 \pm 13.0 \pm 77.9$	$0.9 \pm 0.1^{+2.3}_{-0.9}$	$1.0 \pm 0.1 \pm 0.2$	$0.5 \pm 0.0^{+3.1}_{-0.5}$	353
1j-16	$74.3 \pm 5.0 \pm 21.1$	<0.1	$21.1 \pm 1.9 \pm 6.1$	$15.9 \pm 1.8 \pm 4.6$	$1.7 \pm 0.7 \pm 0.7$	$2.8^{+4.1}_{-2.8} \pm 4.4$	$115.8 \pm 7.0 \pm 22.9$	$0.3 \pm 0.0^{+0.6}_{-0.3}$	<0.4	<0.1	93
1j-17	$124.7 \pm 6.6 \pm 35.9$	<0.1	$27.0 \pm 2.1 \pm 7.5$	$23.3 \pm 2.2 \pm 6.8$	$1.2 \pm 0.3 \pm 0.4$	$2.0^{+5.7}_{-2.0} \pm 5.8$	$178.2 \pm 9.2 \pm 37.7$	$0.3 \pm 0.0^{+0.7}_{-0.3}$	$0.3 \pm 0.1 \pm 0.1$	<0.1	158
1j-18	$60.7 \pm 4.6 \pm 17.8$	<0.1	$9.1 \pm 1.2 \pm 2.8$	$11.8 \pm 1.5 \pm 3.6$	$1.1 \pm 0.4 \pm 0.5$	$2.8^{+3.6}_{-2.8} \pm 3.9$	$85.5 \pm 6.2 \pm 18.8$	$0.1 \pm 0.0^{+0.3}_{-0.1}$	$0.2 \pm 0.1 \pm 0.1$	<0.1	70
1j-19	$39.4 \pm 3.6 \pm 12.2$	<0.1	$8.8 \pm 1.2 \pm 3.0$	$10.0 \pm 1.4 \pm 3.6$	<3.6	$1.3^{+2.9}_{-1.3} \pm 3.0$	$59.7 \pm 5.0 \pm 13.9$	$0.3 \pm 0.0^{+0.7}_{-0.3}$	<0.4	<0.1	57
1j-20	$5.2 \pm 1.3 \pm 3.3$	<0.1	$1.6 \pm 0.5 \pm 0.7$	$2.6 \pm 0.7 \pm 1.2$	$0.4 \pm 0.1 \pm 0.2$	<0.1	$9.8 \pm 1.6 \pm 3.6$	$0.3 \pm 0.1^{+0.8}_{-0.3}$	<0.2	<0.1	5
1j-21	$0.7 \pm 0.5^{+0.8}_{-0.7}$	<0.1	$0.2 \pm 0.2 \pm 0.2$	$2.6 \pm 0.7 \pm 1.0$	<0.1	<0.1	$3.6 \pm 0.9 \pm 1.3$	$0.6 \pm 0.1^{+1.5}_{-0.6}$	$0.3 \pm 0.1 \pm 0.1$	<0.1	5
1j-22	$0.4 \pm 0.4^{+0.7}_{-0.4}$	<0.1	<0.1	$0.7 \pm 0.4 \pm 0.5$	$0.3 \pm 0.1 \pm 0.2$	$1.9 \pm 1.9^{+2.1}_{-1.9}$	$3.3 \pm 2.0 \pm 2.3$	$0.2 \pm 0.0^{+0.4}_{-0.2}$	<0.1	<0.1	1

Table 14. Numbers of expected and observed events in the eμ channel. The total background includes the total uncertainty, while for each process the statistical and systematic uncertainties are quoted separately. The two numbers that are quoted for the benchmark signal models are the masses of the parent SUSY particle and the $\widetilde{\chi}_1^0$, respectively, in GeV. In the case of the chargino-neutralino signal models, the first number within parentheses indicates the common $\widetilde{\chi}_1^{\pm}$ and $\widetilde{\chi}_2^0$ mass in GeV.

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