Z' production at the LHC in an extended MSSM

Gennaro Corcella

INFN, Laboratori Nazionali di Frascati

1. **Introduction**
2. **Z' production in U(1)' and Sequential Standard Model**
3. **MSSM features including U(1)'**
4. **Z' branching ratios in SM and MSSM**
5. **Cross sections and event rates at the LHC**
6. **Conclusions**

Work in progress

In collaboration with Simonetta Gentile (Università di Roma)

Searches for heavy gauge bosons Z' among the main objectives of LHC

Sequential Standard Model (same couplings as SM), string-inspired U(1)' or Kaluza–Klein gravitons

Latest LHC analyses have focused on SM decays, e.g. high-mass dilepton resonances

CMS: $\mathcal{L} = 4.9$ fb^{-1} (dileptons)

$m(Z'_{SSM}) > 2.32$ TeV , $m(Z'_{\psi}) > 2.00$ TeV, $m(Z'_{KK}) > 1.81 - 2.13$ TeV

ATLAS: $\mathcal{L}$=1.08 fb^{-1} (e^+e^-) and $\mathcal{L}$=1.21 fb^{-1} ($\mu^+\mu^-$)

$m(Z'_{SSM}) > 1.83$ TeV , $m(Z'_{U(1)'})$ >1.49-1.64 TeV , $m(Z'_{KK})$ >0.71-1.63 TeV

In BSM analyses, why not BSM Z' decays, e.g. both SM and MSSM modes

Lower SM branching ratios with BSM decays $\Rightarrow$ lower Z' mass exclusion limits

T. Gherghetta et al., PRD57 (1998) 3178: pioneering work on Z' decays in the MSSM, but for $m_{Z'} = 700$ GeV and only one point in the parameter space

C.-F. Chang et al., JHEP09 (2011) 058: two sets of MSSM parameters
and $m_{Z'}$=1-2 TeV, but treating sfermion, gaugino and Higgs masses as free parameters

U(1)' gauge groups in string-inspired models:

$$E_6 \to SO(10) \times U(1)_\psi \quad ; \quad SO(10) \to SU(5) \times U(1)_\chi$$

$$Z'(\theta) = Z'_\psi \cos\theta - Z'_\chi \sin\theta$$

Model	θ
Z'_η	$\arccos\sqrt{5/8}$
Z'_ψ	0
Z'_N	$\arctan\sqrt{15} - \pi/2$
Z'_I	$\arccos\sqrt{5/8} - \pi/2$
Z'_S	$\arctan(\sqrt{15}/9) - \pi/2$
Z'_χ	$-\pi/2$

	$2\sqrt{10}\ Q_\chi$	$2\sqrt{6}\ Q_\psi$	$2\sqrt{15}\ Q_\eta$
Q	-1	1	2
u^c	-1	1	2
d^c	3	1	-1
L	3	1	-1
ℓ^c	-1	1	2
ν^c_ℓ	-5	1	5
H	-2	-2	-1
H^c	2	-2	-4
S^c	0	4	5
D	2	-2	-4
D^c	-2	-2	-1

U(1)' coupling and charges:

$$g' = \sqrt{\frac{5}{3}} g_1 \quad ; \quad Q'(\Phi) = Q'_\psi(\Phi)\cos\theta - Q'_\chi(\Phi)\sin\theta$$

$$Q = (u \;\; d)_L \;, \quad L = (\ell \;\; \nu)_L \;, \quad H = (N \;\; E)_L \;, \; S \text{ singlet}$$

Minimal Supersymmetric Standard Model and U(1)'

The extra Z' requires a singlet Higgs to break U(1)' and get mass

Higgs sector: h, H, A, $H^{\pm}$ (MSSM) and a new scalar H'

Three vacuum expectation values $v_1 < v_2 < v_3 \quad \tan\beta = v_2/v_1$

Gauginos: new $\tilde{Z}'$ and $\tilde{H}'$ lead to two new neutralinos, i.e. $\tilde{\chi}^0_1, \ldots \tilde{\chi}^0_6$

Chargino sector is unchanged, as the Z' is neutral

New Z' decay modes besides the SM ones:

$Z' \to \tilde{q}\tilde{q}^*$, $\tilde{\ell}^+\tilde{\ell}^-$, $\tilde{\nu}\tilde{\nu}^*$, $\tilde{\chi}^0_i\tilde{\chi}^0_j$, $\tilde{\chi}^+_{1,2}\tilde{\chi}^-1,2$, ZH, Zh, ZA, H^+H^-, hA, HA, WW

Gaugino masses not free parmeters, but obtained after diagonalizing the mass matrices in terms of the MSSM parameters M_1, M_2, M', $\tan\beta$, A_f, μ

Examples for pseudoscalar and charged Higgs and chargino masses:

$$m^2_{H^\pm} = \frac{2\sqrt{2}\mu A_f}{\sin 2\beta} + \left(1 - 4\frac{\mu^2}{g_2^2 v_3^2}\right) m_W^2 \quad , \quad m^2_A = \frac{\sqrt{2}\mu A_f v_3}{\sin 2\beta}\left(1 + \frac{v_1^2 + v_2^2}{4v_3^2}\sin^2 2\beta\right)$$

$$m^2_{\tilde{\chi}^\pm_{1,2}} = \frac{1}{2}\left[|M_2|^2 + |\mu|^2 + 2m_W^2 \mp \sqrt{(|M_2|^2 + |\mu|^2 + 2m_W^2)^2 - 4|\mu M_2 - m_W^2 \sin 2\beta|^2}\right]$$

Sfermion masses m_a^2 get D-term contributions: $m^2 = m_0^2 + \Delta m_D^2$

m_0: common sfermion mass at the Z' scale

First contribution: hyperfine splitting due to electroweak symmetry breaking

$$\Delta\tilde{m}_a^2 = (T_{3,a} g_1^2 - Y_a g_2^2)(v_1^2 - v_2^2) = (T_{3,a} - Q_a \sin^2\theta_W) m_Z^2 \cos 2\beta$$

Second contribution driven by the new U(1)' symmetry:

$$\Delta\tilde{m}_a'^2 = \frac{g'^2}{2}(Q_1' v_1^2 + Q_2' v_2^2 + Q_3' v_3^2)$$

$$\mathcal{M}_{\tilde{f}}^2 = \begin{pmatrix} (M_{\rm LL}^{\tilde{f}})^2 & (M_{\rm LR}^{\tilde{f}})^2 \\ (M_{\rm LR}^{f})^2 & (M_{\rm RR}^{f})^2 \end{pmatrix}$$

$$\begin{aligned}
(M_{\rm LL}^{\tilde{u}})^2 &= (m_{\tilde{u}_{\rm L}}^0)^2 + m_u^2 + \left(\frac{1}{2} - \frac{2}{3}x_w\right) m_Z^2 \cos 2\beta + Q'_{\tilde{u}_{\rm L}} \Delta\tilde{m}'^2_{\tilde{u}_L} \\
(M_{\rm RR}^{\tilde{u}})^2 &= (m_{\tilde{u}_R}^0)^2 + m_u^2 + \left(\frac{1}{2} - \frac{2}{3}x_w\right) m_Z^2 \cos 2\beta + Q'_{\tilde{u}_R} \Delta\tilde{m}'^2_{\tilde{u}_R} \\
(M_{\rm LR}^{\tilde{u}})^2 &= m_u (A_u - \mu \cot\beta) \,.
\end{aligned}$$

Mass eigenstates $\tilde{u}_{1,2}$, $\tilde{d}_{1,2}$ $\tilde{\ell}_{1,2}$, $\tilde{\nu}_{1,2}$ – mixing term relevant only for stop quarks

Representative Point:

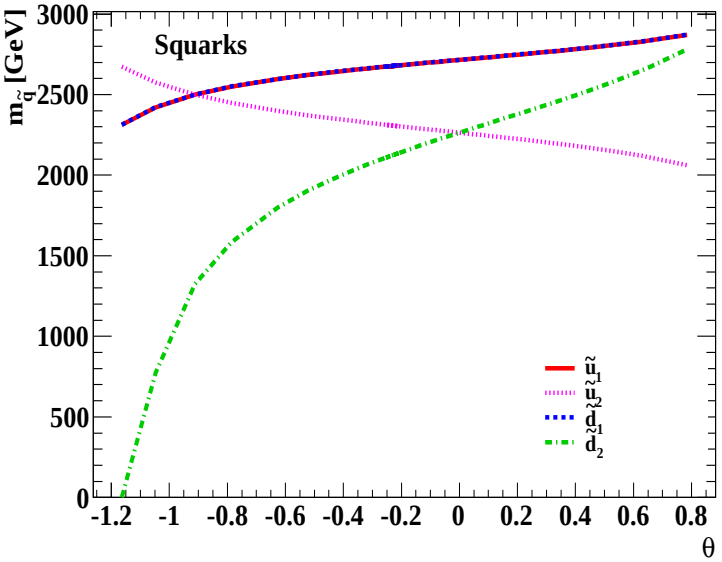
$$m_{Z'} = 3 \text{ TeV} \ , \ \theta = \theta_I = \arccos\sqrt{\frac{5}{8}} - \frac{\pi}{2}$$

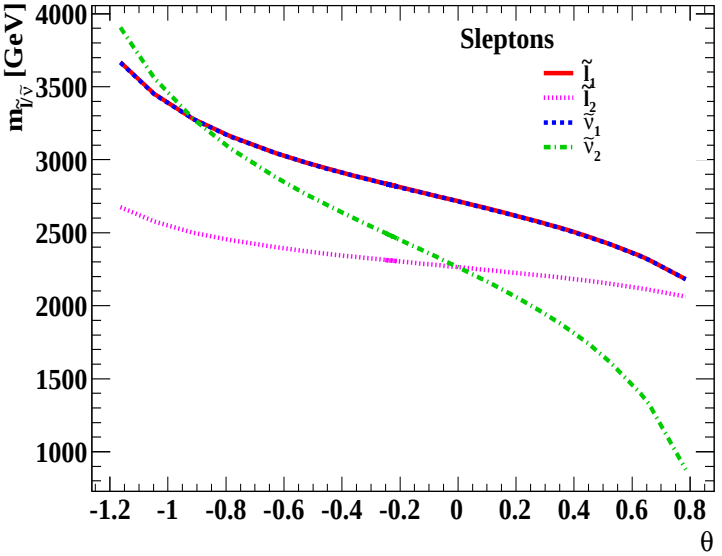
$$\mu = 200 \ , \ \tan\beta = 20 \ , \ A_q = A_\ell = A_f = 500 \text{ GeV}$$

$$m^0_{\tilde{q}_L} = m^0_{\tilde{q}_R} = m^0_{\tilde{\ell}_L} = m^0_{\tilde{\ell}_R} = m^0_{\tilde{\nu}_L} = m_{\tilde{\nu}_R} = 2.5 \text{ TeV}$$

$$M_1 = 100 \text{ GeV} \ , \ M_2 = 200 \text{ GeV} \ , \ M' = 1 \text{ TeV}$$

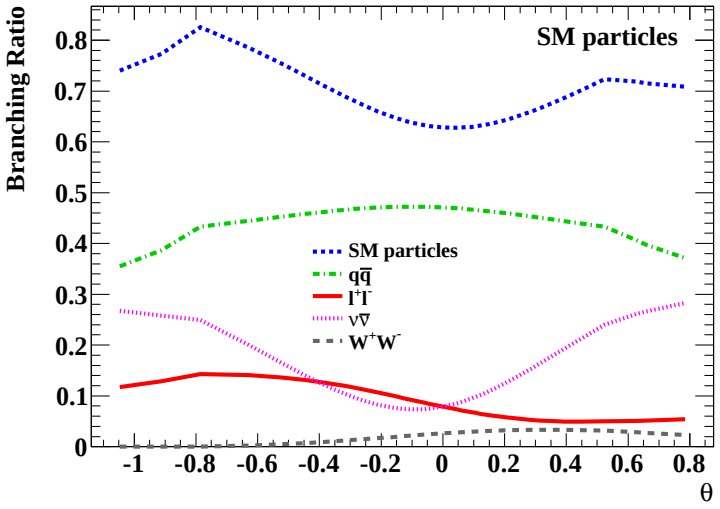
$m_{\tilde{u}_1}$	$m_{\tilde{u}_2}$	$m_{\tilde{d}_1}$	$m_{\tilde{d}_2}$	$m_{\tilde{\ell}_1}$	$m_{\tilde{\ell}_2}$	$m_{\tilde{\nu}_1}$	$m_{\tilde{\nu}_2}$
2499.4	2499.7	2500.7	1323.1	3279.0	2500.4	3278.1	3279.1
$m_{\tilde{\chi}^0_1}$	$m_{\tilde{\chi}^0_2}$	$m_{\tilde{\chi}^0_3}$	$m_{\tilde{\chi}^0_4}$	$m_{\tilde{\chi}^0_5}$	$m_{\tilde{\chi}^0_6}$	$m_{\tilde{\chi}^\pm_1}$	$m_{\tilde{\chi}^\mp_2}$
94.6	156.5	212.2	260.9	2541.4	3541.4	154.8	262.1
m_h	m_A	m_H	$m_{H'}$	$m_{H^\pm}$			
90.7	1190.7	1190.7	3000.0	1193.4			

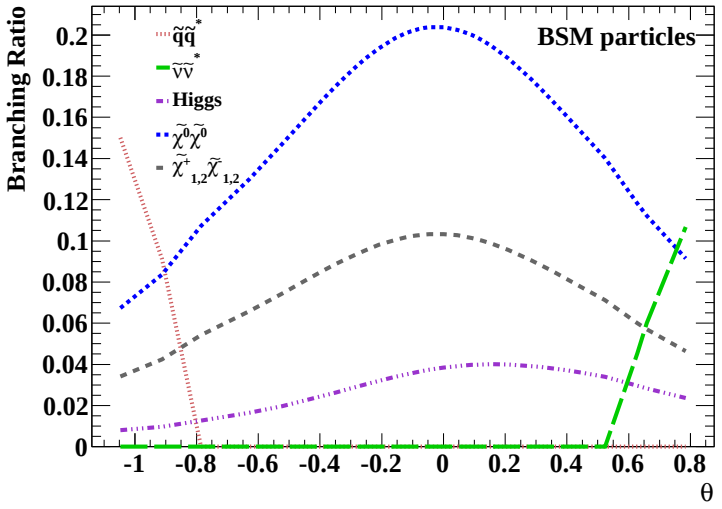




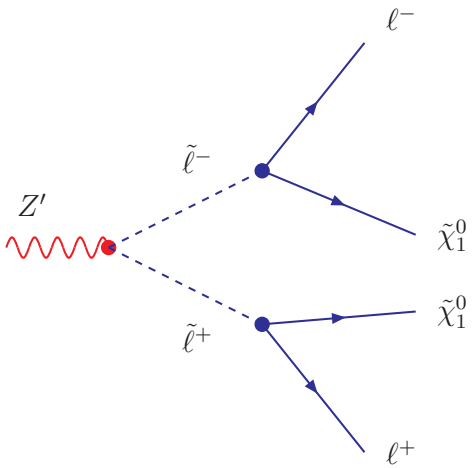
Branching ratios:

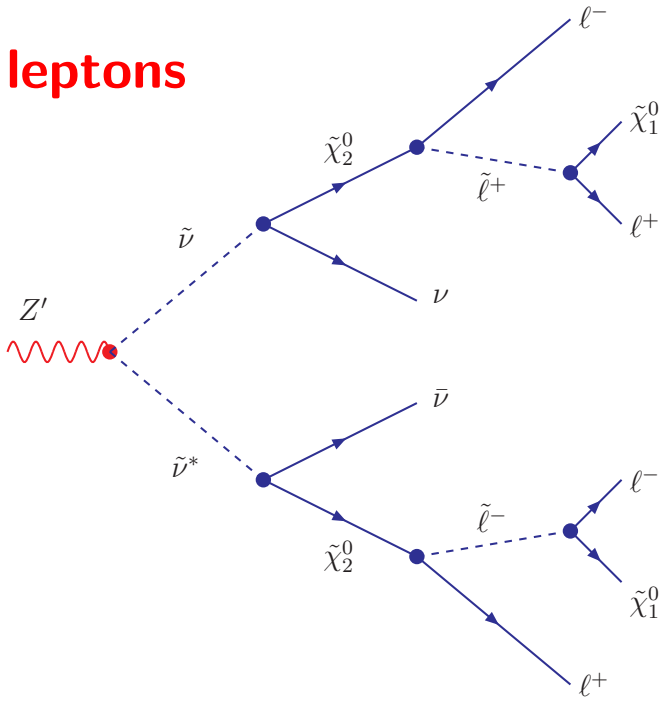
Final state	BR (%)	Final State	BR (%)
$\sum_i u_i\bar{u}_i$	0.00	$\tilde{\chi}_1^0\tilde{\chi}_1^0$	0.07
$\sum_i d_i\bar{d}_i$	40.67	$\tilde{\chi}_1^0\tilde{\chi}_2^0$	0.43
$\sum_i \ell_i^+\ell_i^-$	13.56	$\tilde{\chi}_1^0\tilde{\chi}_3^0$	0.71
$\sum_i \nu_i\bar{\nu}_i$	27.11	$\tilde{\chi}_1^0\tilde{\chi}_4^0$	0.27
$\sum_{i,j} \tilde{u}_i\tilde{u}_j^*$	0.00	$\tilde{\chi}_1^0\tilde{\chi}_5^0$	$\sim 10^{-6}$
$\sum_{i,j} \tilde{d}_i\tilde{d}_j^*$	9.58	$\tilde{\chi}_2^0\tilde{\chi}_2^0$	0.65
$\sum_{i,j} \tilde{\ell}_i\tilde{\ell}_j^*$	0.00	$\tilde{\chi}_2^0\tilde{\chi}_3^0$	2.13
$\sum_{i,j} \tilde{\nu}_i\tilde{\nu}_j^*$	0.00	$\tilde{\chi}_2^0\tilde{\chi}_4^0$	0.80
H^+H^-	0.50	$\tilde{\chi}_3^0\tilde{\chi}_3^0$	1.75
hA	$\sim 10^{-3}$	$\tilde{\chi}_3^0\tilde{\chi}_4^0$	1.31
HA	0.51	$\tilde{\chi}_3^0\tilde{\chi}_5^0$	$\sim 10^{-6}$
ZH	$\sim 10^{-3}$	$\tilde{\chi}_4^0\tilde{\chi}_4^0$	0.25
ZH'	0.00	$\tilde{\chi}_1^\pm\tilde{\chi}_2^\mp$	1.95
$H'A$	0.00	$\tilde{\chi}_2^\pm\tilde{\chi}_2^\mp$	0.54
$W^\pm H^\mp$	$\sim 10^{-3}$	$\tilde{\chi}_1^\pm\tilde{\chi}_1^\mp$	1.76

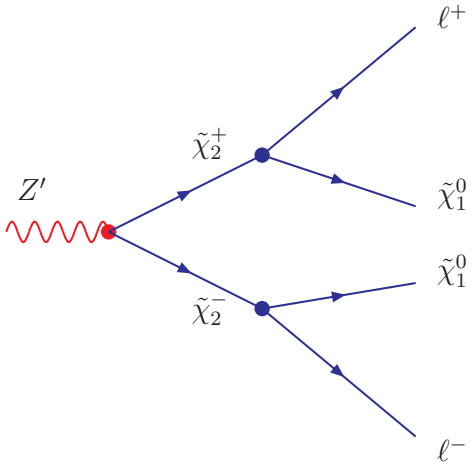


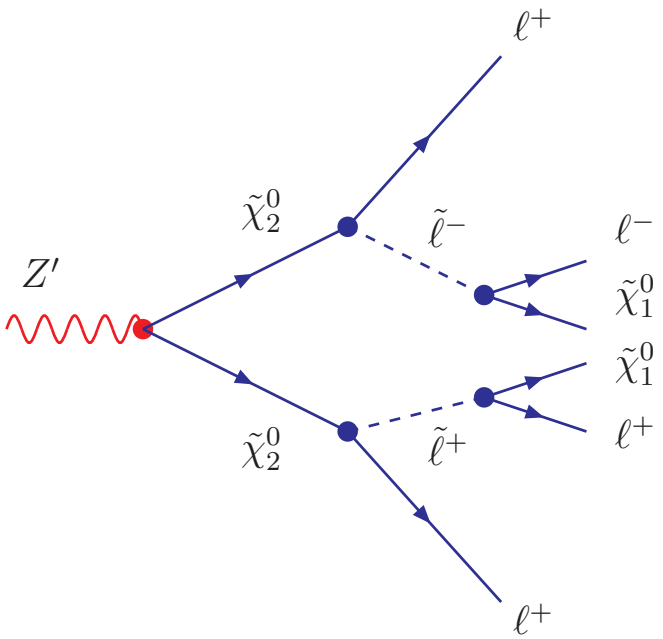


Z' decays into final states with leptons









Branching ratios into SM and BSM particles varying the Z' and slepton masses

$\mu = 200$, $\tan\beta = 20$, $A_q = A_\ell = 500$ GeV , $m^0_{\tilde{q}} = 5$ TeV , $M_1 = 150$ GeV , $M_2 = 300$ GeV , $M' = 1$ TeV

Z'_η ($\theta \simeq 0.66$):

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$\mathrm{B}_{q\bar{q}}$	$\mathrm{B}_{\ell\ell}$	$\mathrm{B}_{\nu\nu}$	B_{WW}	B_{ZH}	$\mathrm{B}_{\tilde{\chi}^\pm\tilde{\chi}^\mp}$	$\mathrm{B}_{\tilde{\chi}^0\tilde{\chi}^0}$	$\mathrm{B}_{\tilde{\nu}\tilde{\nu}^*}$	B_{SM}	$\mathrm{B}_{\mathrm{BSM}}$
1.0	0.8	39.45	5.24	27.26	3.01	2.91	4.92	8.64	8.54	71.96	28.04
1.5	1.1	37.82	4.93	25.63	2.71	2.67	5.16	9.76	11.31	68.39	31.61
2.0	1.5	37.97	4.91	25.54	2.66	2.64	5.33	10.33	10.61	68.42	31.58
2.5	1.8	37.46	4.83	25.12	2.60	2.59	5.33	10.44	11.61	67.42	32.58
3.0	2.2	37.60	4.84	25.17	2.59	2.59	5.38	10.61	11.14	67.60	32.40
3.5	2.5	37.30	4.80	24.94	2.56	2.56	5.36	10.61	11.73	67.03	32.97
4.0	2.9	37.41	4.81	25.00	2.56	2.56	5.39	10.70	11.38	67.22	32.78

Z'_ψ ($\theta = 0$) :

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$\mathrm{B}_{q\bar{q}}$	$\mathrm{B}_{\ell\ell}$	$\mathrm{B}_{\nu\nu}$	B_{WW}	B_{ZH}	$\mathrm{B}_{\tilde{\chi}^\pm\tilde{\chi}^\mp}$	$\mathrm{B}_{\tilde{\chi}^0\tilde{\chi}^0}$	$\mathrm{B}_{\tilde{\nu}\tilde{\nu}^*}$	$\mathrm{B}_{\tilde{\ell}\tilde{\ell}^*}$	B_{SM}	$\mathrm{B}_{\mathrm{BSM}}$
1.0	0.4	48.16	8.26	8.26	3.00	2.89	9.13	16.53	1.91	1.90	64.69	35.31
1.5	0.6	46.78	7.90	7.90	2.71	2.69	9.73	18.64	1.83	1.83	62.57	37.43
2.0	0.8	46.30	7.77	7.77	2.62	2.62	9.92	19.37	1.80	1.80	61.85	38.15
2.5	1.0	46.01	7.70	7.70	2.58	2.59	9.99	19.68	1.79	1.78	61.42	38.58
3.0	1.1	45.35	7.58	7.58	2.53	2.54	9.92	19.63	1.86	1.86	60.51	39.49
3.5	1.3	44.91	7.50	7.50	2.49	2.51	9.86	19.58	1.83	1.83	59.92	40.08
4.0	1.5	44.60	7.45	7.45	2.47	2.49	9.82	19.53	1.80	1.80	59.49	40.51
4.5	1.6	44.32	7.40	7.40	2.45	2.47	9.78	19.47	1.84	1.84	59.11	40.89
5.0	1.8	44.16	7.37	7.37	2.44	2.46	9.76	19.44	1.82	1.82	58.89	41.11

Z'_N ($\theta \simeq -0.25$):

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$\mathrm{B}_{q\bar{q}}$	$\mathrm{B}_{\ell\ell}$	$\mathrm{B}_{\nu\nu}$	B_{WW}	B_{ZH}	$\mathrm{B}_{\tilde{\chi}^\pm\tilde{\chi}^\mp}$	$\mathrm{B}_{\tilde{\chi}^0\tilde{\chi}^0}$	$\mathrm{B}_{\tilde{\ell}\tilde{\ell}}$	B_{SM}	$\mathrm{B}_{\mathrm{BSM}}$
1.0	0.4	49.51	11.98	9.59	1.71	1.68	8.71	15.78	1.04	71.08	28.92
1.5	0.5	47.99	11.51	9.21	1.57	1.57	9.26	17.76	1.12	68.71	31.29
2.0	0.7	47.50	11.36	9.08	1.53	1.54	9.44	18.46	1.08	67.94	32.06
2.5	0.8	47.16	11.26	9.01	1.50	1.52	9.50	18.73	1.12	67.42	32.58
2.5	1.5	47.69	11.38	9.11	1.52	1.53	9.61	18.94	0.00	68.18	31.82
3.0	1.0	46.43	11.30	8.86	1.47	1.49	9.43	18.66	1.08	66.36	33.64
3.5	1.2	45.85	10.93	8.74	1.45	1.47	9.35	18.56	1.05	65.53	34.47
4.0	1.3	45.42	10.83	8.66	1.43	1.45	9.29	18.47	1.07	64.91	35.09
4.5	1.5	45.13	10.75	8.60	1.42	1.44	9.24	18.41	1.05	64.48	35.52
5.0	1.6	44.90	10.70	8.56	1.41	1.43	9.21	18.35	1.06	64.15	35.85

Z'_I ($\theta \simeq -0.91$) :

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$\mathrm{B}_{q\bar{q}}$	$\mathrm{B}_{\ell\ell}$	$\mathrm{B}_{\nu\nu}$	$\mathrm{B}_{H^+H^-}$	B_{WH}	B_{HA}	$\mathrm{B}_{\tilde{\chi}^\pm\tilde{\chi}^\mp}$	$\mathrm{B}_{\tilde{\chi}^0\tilde{\chi}^0}$	B_{SM}	$\mathrm{B}_{\mathrm{BSM}}$
1.0	1.0	44.06	14.69	29.37	0.00	$\sim 10^{-3}$	$\sim 10^{-4}$	4.31	7.58	88.11	11.89
1.5	1.0	43.39	14.46	28.93	0.00	$\sim 10^{-4}$	$\sim 10^{-4}$	4.56	8.65	86.78	13.22
2.0	1.0	43.16	14.38	28.77	0.00	$\sim 10^{-4}$	$\sim 10^{-3}$	4.65	9.03	86.31	13.69
2.5	1.0	42.99	14.33	28.66	0.06	$\sim 10^{-3}$	0.07	4.68	9.19	85.98	14.02
3.0	1.0	42.53	14.18	28.36	0.53	$\sim 10^{-3}$	0.53	4.66	9.20	85.07	14.93
3.5	1.0	42.16	14.05	28.11	0.91	$\sim 10^{-3}$	0.92	4.64	9.19	84.33	15.67
4.0	1.0	41.90	13.96	27.93	1.20	$\sim 10^{-3}$	1.21	4.62	9.17	83.79	16.21
4.5	1.0	41.70	13.90	27.80	1.40	$\sim 10^{-3}$	1.41	4.61	9.16	83.40	16.60
5.0	1.0	41.56	13.85	27.71	1.56	0.01	1.57	4.60	9.15	83.12	16.88

Z'_S $(\theta \simeq -1.16)$:

$m_{Z'}$	$m^0_{\tilde{\ell}}$	$\mathrm{B}_{q\bar{q}}$	$\mathrm{B}_{\ell\ell}$	$\mathrm{B}_{\nu\nu}$	B_{WW}	B_{ZH}	$\mathrm{B}_{\tilde{\chi}^\pm\tilde{\chi}^\mp}$	$\mathrm{B}_{\tilde{\chi}^0\tilde{\chi}^0}$	$\mathrm{B}_{\tilde{\ell}\tilde{\ell}^*}$	$\mathrm{B}_{\tilde{q}\tilde{q}^*}$	B_{SM}	$\mathrm{B}_{\mathrm{BSM}}$
1.0	0.2	42.29	13.70	34.57	0.15	0.14	3.33	5.75	0.07	0.00	90.56	9.44
1.5	0.2	41.84	13.54	34.16	0.15	0.14	3.51	6.59	0.07	0.00	89.54	10.46
2.0	0.2	41.67	13.48	34.02	0.14	0.14	3.57	6.90	0.08	0.00	89.17	10.82
2.5	0.2	41.56	13.44	33.91	0.14	0.14	3.59	7.03	0.08	0.00	88.92	11.08
3.0	0.2	41.25	13.34	33.66	0.14	0.14	3.58	7.06	0.08	0.00	88.25	11.75
3.5	0.2	40.99	13.26	33.45	0.14	0.14	3.57	7.07	0.08	0.00	87.70	12.30
4.0	0.2	40.81	13.20	33.30	0.14	0.14	3.56	7.07	0.08	0.00	87.30	12.70
4.5	0.2	40.67	13.15	33.19	0.14	0.14	3.56	7.07	0.08	0.00	87.01	12.99
5.0	0.2	37.34	12.07	30.46	0.13	0.13	3.27	6.50	0.07	7.97	79.87	20.12

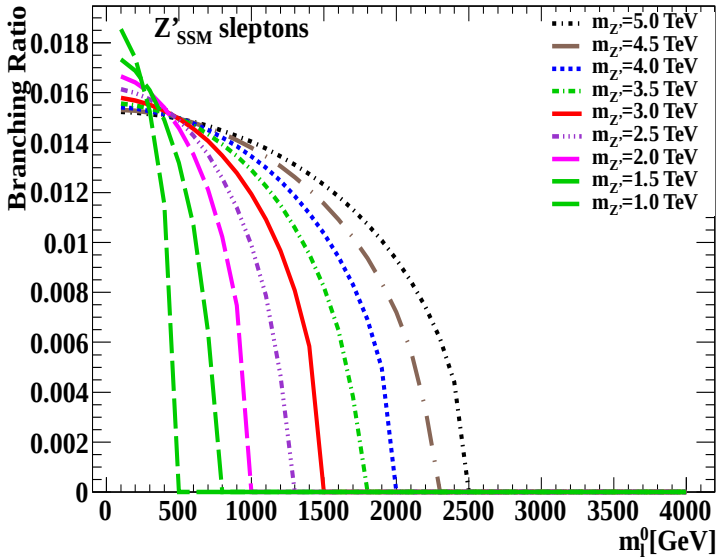
Z'_χ $(\theta \simeq -1.57)$:

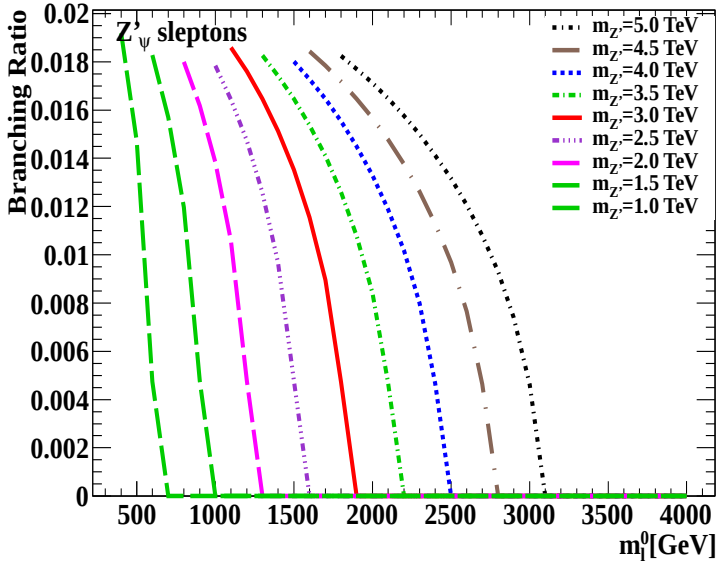
$m_{Z'}$	$\mathrm{B}_{q\bar{q}}$	$\mathrm{B}_{\ell\ell}$	$\mathrm{B}_{\nu\nu}$	B_{WW}	$\mathrm{B}_{H^\pm H^\mp}$	B_{ZH}	B_{HA}	B_{SM}	$\mathrm{B}_{\mathrm{BSM}}$
1.0	44.35	12.44	42.29	0.90	0.00	0.02	$\sim 10^{-3}$	99.08	0.92
2.0	44.32	12.34	41.96	0.84	0.00	0.28	0.26	98.62	1.38
3.0	44.03	12.24	41.63	0.82	0.24	0.53	0.52	97.89	2.11
4.0	43.84	12.18	41.43	0.82	0.46	0.64	0.63	97.45	2.55
5.0	43.74	12.15	41.33	0.81	0.58	0.70	0.69	97.22	2.78

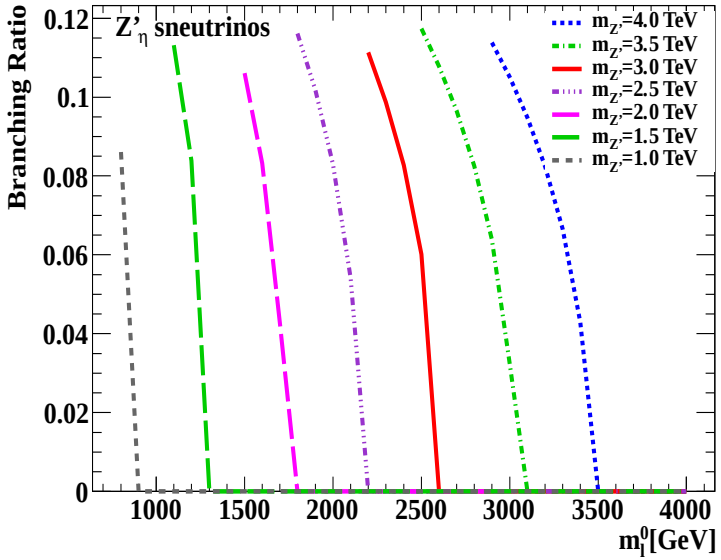
$Z'_{\rm SSM}$:

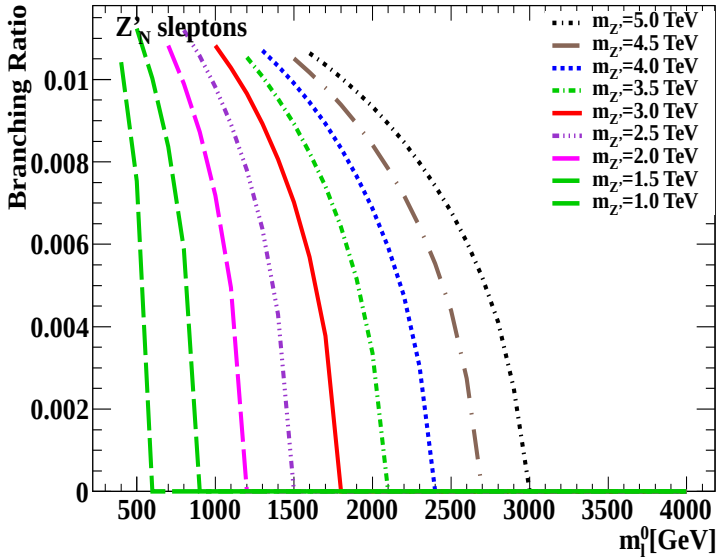
$m_{Z'}$	$m^0_{\tilde{\ell}}$	B_q	B_ℓ	B_ν	B_{WW}	B_{HH}	B_{Zh}	B_{hA}	B_{ch}	B_{neu}	$\mathrm{B}_{\tilde{\ell}}$	$\mathrm{B}_{\tilde{\nu}}$	$\mathrm{B}_{\rm SM}$	$\mathrm{B}_{\rm BSM}$
1.0	0.1	29.6	3.9	7.7	5.6	0.0	0.0	0.0	18.3	29.3	1.9	3.8	41.2	58.8
1.0	0.5	31.4	4.1	8.2	5.9	0.0	0.0	0.0	19.4	31.1	0.0	0.0	43.6	56.4
1.5	0.1	27.4	3.5	7.0	4.9	0.9	0.9	0.8	17.8	32.5	1.7	3.5	37.9	62.1
1.5	0.7	28.9	3.7	7.4	5.1	0.0	0.9	0.8	18.8	34.3	0.0	0.0	40.0	60.0
2.0	0.1	26.2	3.4	6.7	4.6	0.0	1.9	1.8	17.4	33.0	1.7	3.3	36.3	63.7
2.0	1.0	27.6	3.5	7.0	4.8	0.0	2.0	1.9	18.3	34.7	0.0	0.0	38.2	61.8
2.5	0.1	25.4	3.3	6.5	4.4	0.9	2.6	2.5	16.9	32.8	1.6	3.2	35.1	64.9
2.5	1.2	26.6	3.4	6.8	4.6	0.9	2.7	2.7	17.8	34.4	0.0	0.0	36.8	63.2
3.0	0.1	24.8	3.2	6.3	4.2	1.7	3.0	2.9	16.6	32.5	1.6	3.1	34.3	65.7
3.0	1.5	26.0	1.7	6.6	4.5	1.8	3.1	3.1	17.4	34.1	0.0	0.0	36.0	64.0
3.5	0.1	24.4	3.1	6.2	4.2	2.3	3.2	3.2	16.4	32.3	1.6	3.1	33.7	66.2
3.5	1.7	25.6	1.4	6.5	4.4	2.4	3.4	3.3	17.2	33.9	0.0	0.0	35.4	64.6
4.0	0.1	24.2	3.1	6.1	4.1	2.6	3.4	3.4	16.3	32.2	1.5	3.1	33.4	66.6
4.0	2.0	25.3	1.2	6.4	4.3	2.8	3.6	3.5	17.1	33.7	0.0	0.0	35.0	65.0
4.5	0.1	24.0	3.1	6.1	4.1	2.9	3.5	3.5	16.2	32.1	1.5	3.0	33.2	66.8
4.5	2.2	25.1	1.1	6.4	4.3	3.0	3.7	3.7	17.0	33.6	0.0	0.0	34.8	65.2
5.0	0.1	23.9	3.0	6.1	4.1	3.1	3.6	3.6	16.1	32.0	1.5	3.0	33.0	67.0
5.0	2.5	25.0	1.0	6.4	4.2	3.3	3.8	3.7	16.9	33.5	0.0	0.0	34.6	65.4

Dependence of branching ratios on Z' and slepton masses

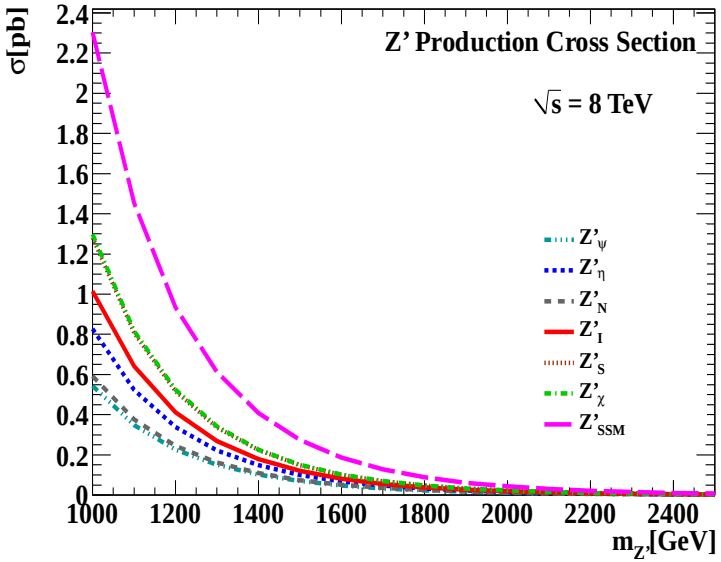


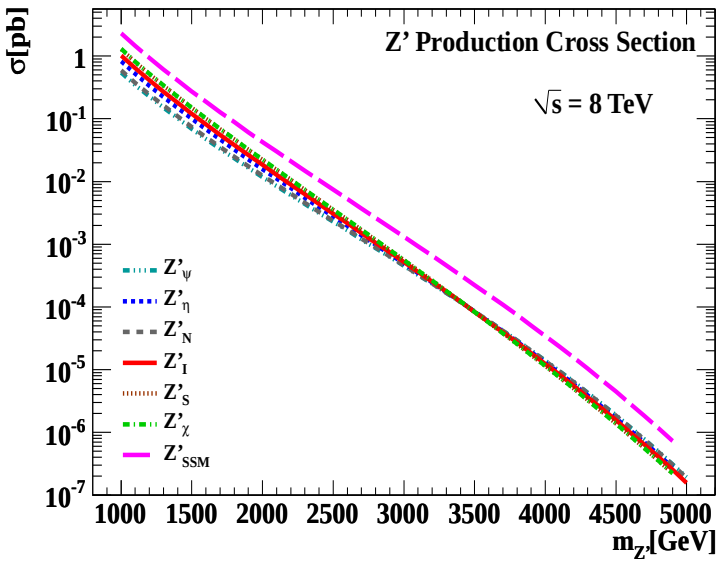


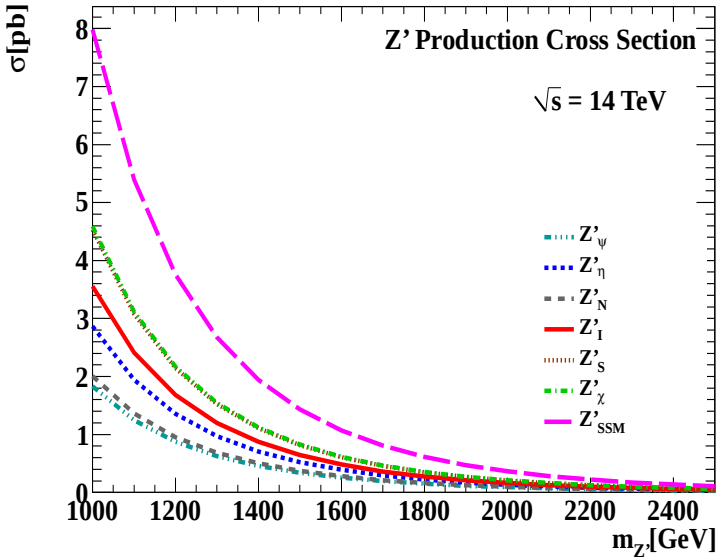


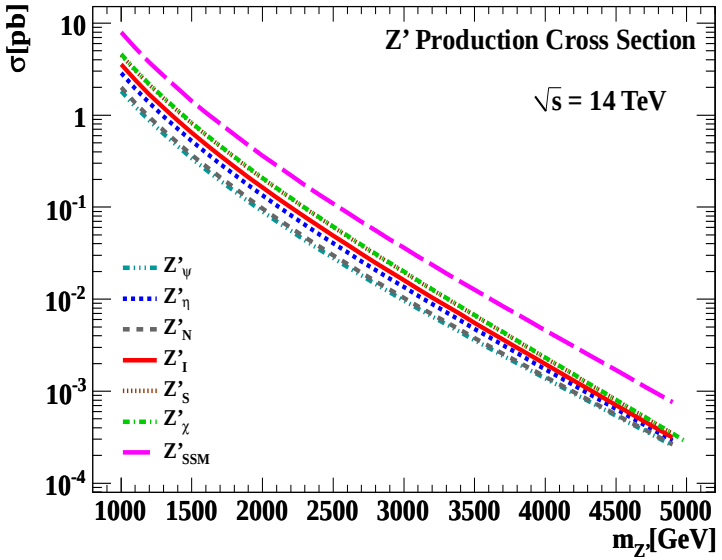


Production cross sections in pp collisions $q\bar{q} \to Z'$, LO pdf CTEQ6L









Expected event numbers (narrow width approximation):

$$\sigma(pp \to Z' \to f_1 f_2) \simeq \sigma(pp \to Z') \times \mathrm{BR}(Z' \to f_1 f_2)\ ;\ \mathrm{N} = \mathcal{L}\sigma$$

Cascade events: $\mathrm{N}_{\mathrm{casc}} = \mathrm{N}(\tilde{\nu}\tilde{\nu}^*) + \mathrm{N}(\tilde{\chi}^+\tilde{\chi}^-) + \mathrm{N}(\tilde{\chi}^0\tilde{\chi}^0)$

Charged-slepton events: $\mathrm{N}_{\mathrm{slep}} = \mathrm{N}(\tilde{\ell}^+\tilde{\ell}^-)$

$\sqrt{s} = 8$ TeV $\mathcal{L} = 20\ \mathrm{fb}^{-1}$

Model	$m_{Z'}$ (TeV)	$\mathrm{N}_{\mathrm{casc}}$	$\mathrm{N}_{\mathrm{slep}}$
Z'_η	1.5	523	–
Z'_η	2.0	55	–
Z'_ψ	1.5	599	36
Z'_ψ	2.0	73	4
Z'_{N}	1.5	400	17
Z'_{N}	2.0	70	3
Z'_I	1.5	317	–
Z'_I	2.0	50	–
Z'_S	1.5	30	–
Z'_S	2.0	46	–
Z'_{SSM}	1.5	2968	95
Z'_{SSM}	2.0	462	14

$\sqrt{s} = 14$ TeV $\mathcal{L} = 100\ \mathrm{fb}^{-1}$

Model	$m_{Z'}$ (TeV)	$\mathrm{N}_{\mathrm{casc}}$	$\mathrm{N}_{\mathrm{slep}}$
Z'_η	1.5	13650	–
Z'_η	2.0	2344	–
Z'_ψ	1.5	10241	622
Z'_ψ	2.0	2784	162
Z'_{N}	1.5	9979	414
Z'_{N}	2.0	2705	104
Z'_I	1.5	8507	–
Z'_I	2.0	2230	–
Z'_S	1.5	8242	65
Z'_S	2.0	2146	16
Z'_{SSM}	1.5	775715	24774
Z'_{SSM}	2	19570	606

Conclusions and outlook

Work in progress on Z' phenomenology in supersymmetry at the LHC

BSM modes decrease the SM rates and the Z' may set a constrain on sparticle invariant masses

Marrying U(1)' and MSSM: two extra neutralinos, and one new neutral scalar Higgs, D-term contribution to sfermion masses

Studies of mass spectra, Z' branching ratios and production cross sections spanning the parameter space

BSM branching ratios 10-30% for U(1)' groups and up to 60% for SSM

Up to $\mathcal{O}(10^5)$ supersymmetric events with sleptons and gauginos in the high-luminosity phase of the LHC, especially for SSM

In progress:

Release of the paper and documentation of the calculations

Implementation of the U(1)'/MSSM models in HERWIG: parton showers, Z' width effects, hadronization and acceptance cuts on jets and leptons

Revisiting the limits on the Z' mass