Some topics at 100TeV collider

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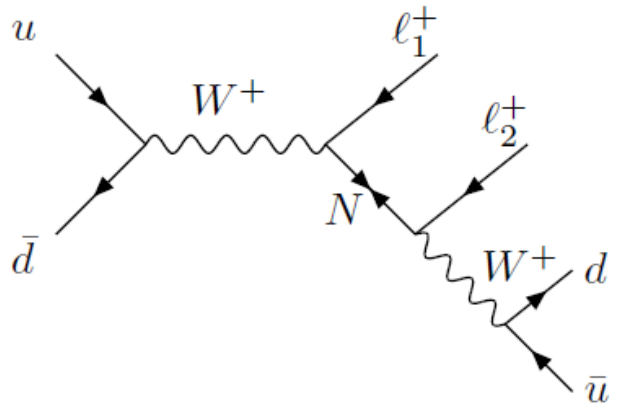
Signatures of Majorana neutrinos at 100TeV collider

Search for Like-sign Dilepton Signals at the LHC



Cuts

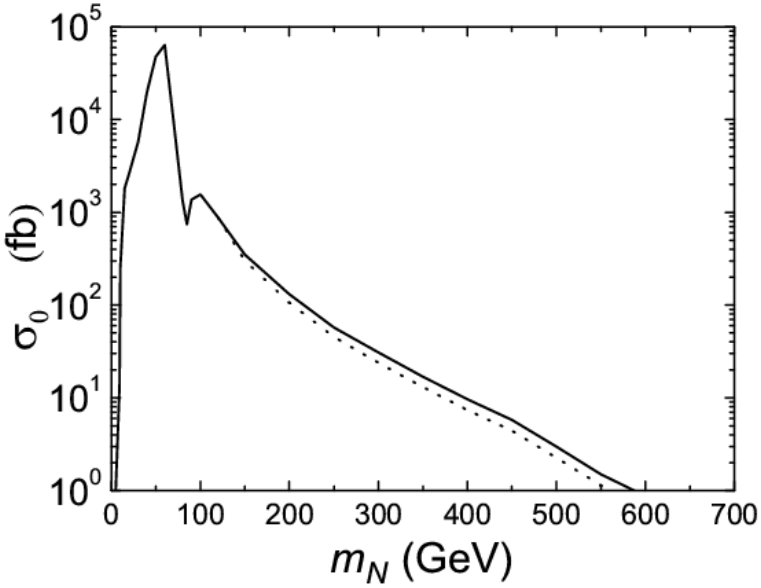
$$p_T(\mu) > 10 \text{ GeV}, \quad \eta(\mu) < 2.5,$$
$$p_T(j) > 15 \text{ GeV}, \quad \eta(j) < 3.0,$$
$$\Delta R_{lj}^{min} > 0.5, \quad \not{p}_T < 25 \text{ GeV}.$$

The N resonance window

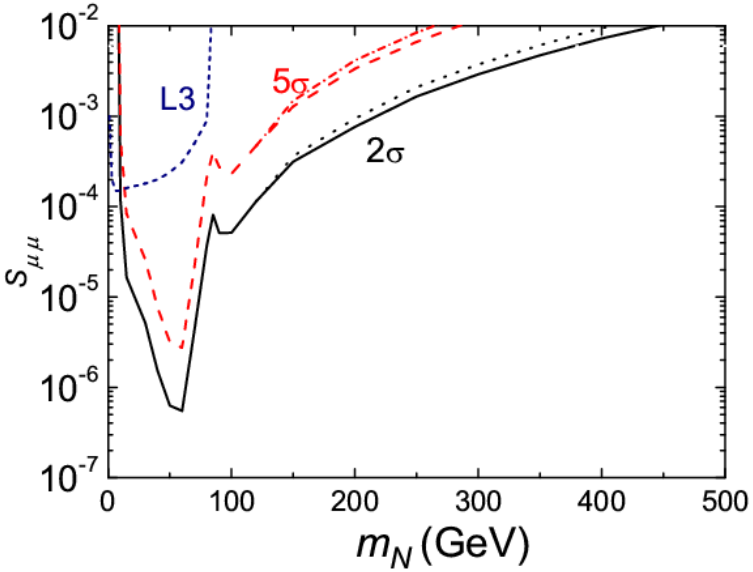
$$0.8 m_N < m(jj\mu) \approx m_N < 1.2 m_N.$$

The leading SM background is $pp \to W^{\pm}W^{\pm}W^{\mp} \to \ell^{\pm}\ell^{\pm}\nu\nu\ jj,$

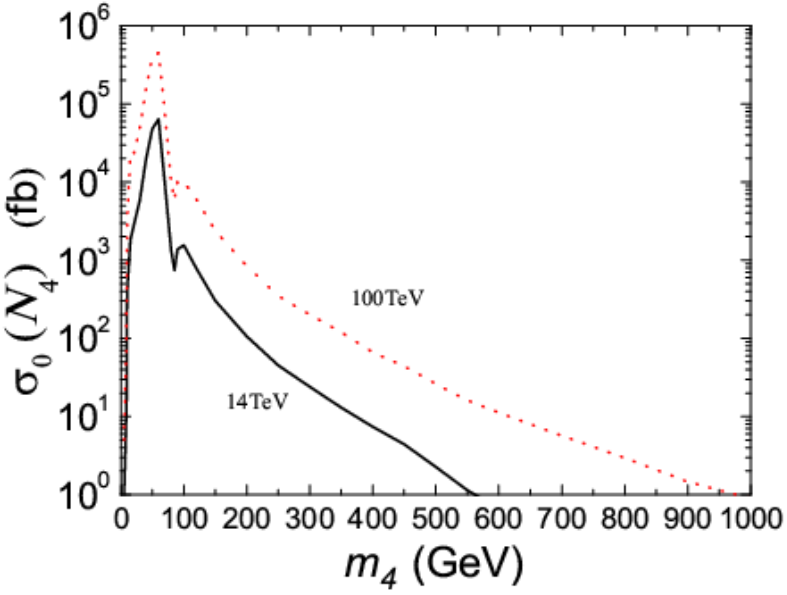
The total background is about 7-8 events for 100 / fb at the LHC

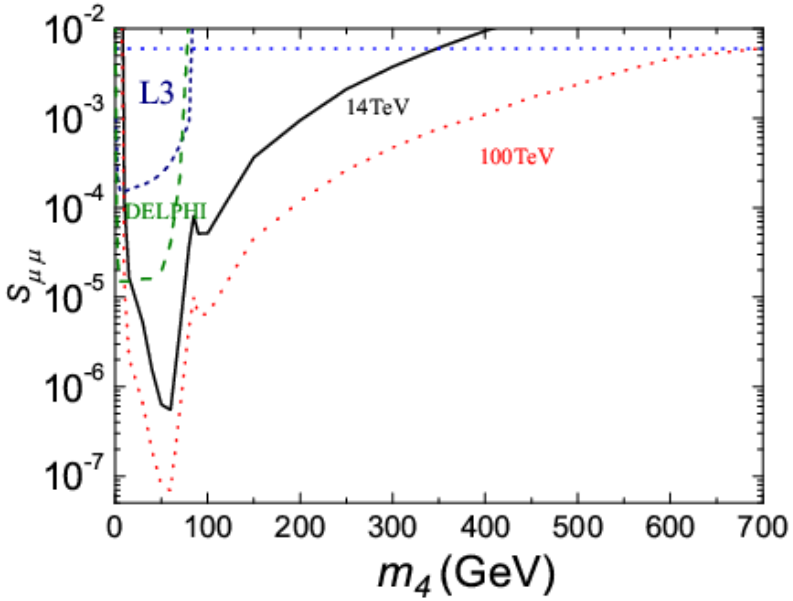

σ_0 (fb)
m_N (GeV)

(a)


L3
5σ
2σ
$S_{\mu\mu}$
m_N (GeV)

(b)


$\sigma_0(N_4)$ (fb)
100TeV
14TeV
m_4 (GeV)


L3
DELPHI
14TeV
100TeV
$S_{\mu\mu}$
m_4 (GeV)

Exotic leptons at the LHC/100TeV

a vector-like $SU(2)$ triplet of exotic leptons with hypercharge $Y = -1$:

$$X = \begin{pmatrix} X^0 \\ X^- \\ X^{--} \end{pmatrix} \in (3, -1).$$

doublet X with hypercherge $Y_X = -3/2$:

$$X = \begin{pmatrix} X^- \\ X^{--} \end{pmatrix} \in (2, -3/2)\,,$$

For these degenerate massive exotic leptons whose masses are above the scale of M_W, the dominant decay modes are

$$X \to \ell + W, Z \text{ or } H$$

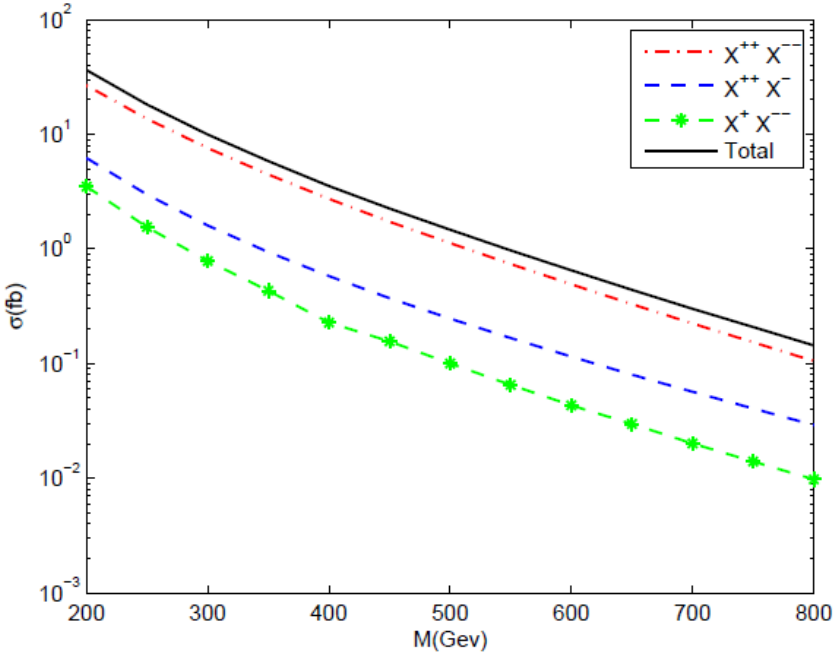
The doubly charged lepton $X^{++}X^{--}$ pair production channel

$$pp \to X^{--}X^{++} \to \ell^- W^- \ell^+ W^+ \to \ell^- \ell^+ jj \ell^- \bar{\nu}(\ell^+ \nu)$$

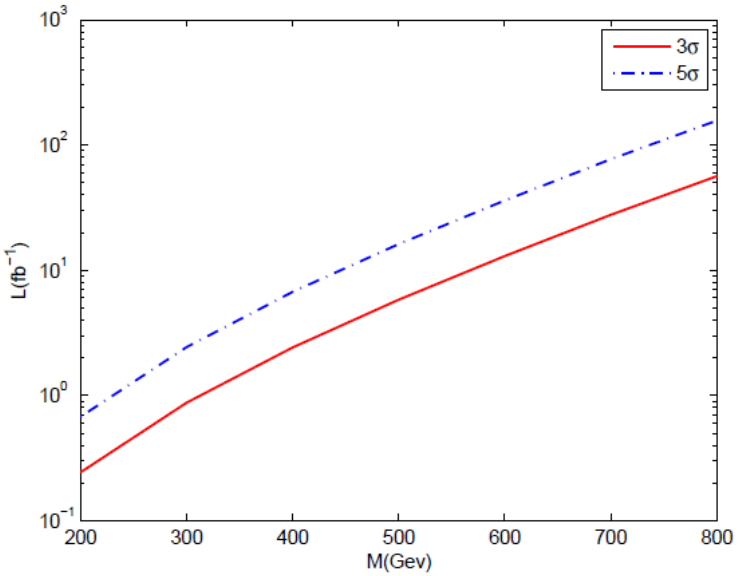
Additional signature at LHC with the same final states

$$pp \to X^{--}X^{+} + h.c. \to \ell^- W^- \ell^+ Z + h.c. \to \ell^- \ell^+ jj \ell^- \bar{\nu}(\ell^+ \nu)$$

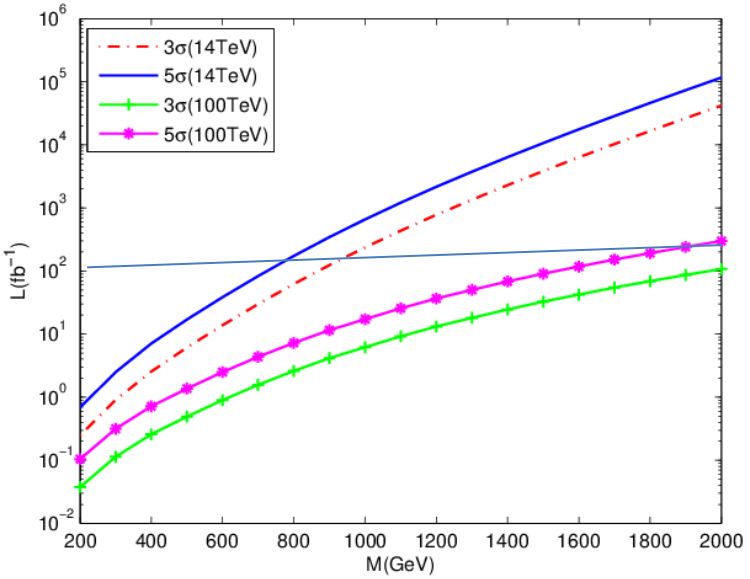
signal cross section in the $\ell^- \ell^+ jj \ell^- \bar{\nu}(\ell^+ \nu)$ channel at 14 TeV LHC, after the cuts.



The needed luminosity to observe different mass triplet leptons via $\ell^-\ell^+jj\ell^-\bar{\nu}(\ell^+\nu)$



LHC



LHC vs 100TeV

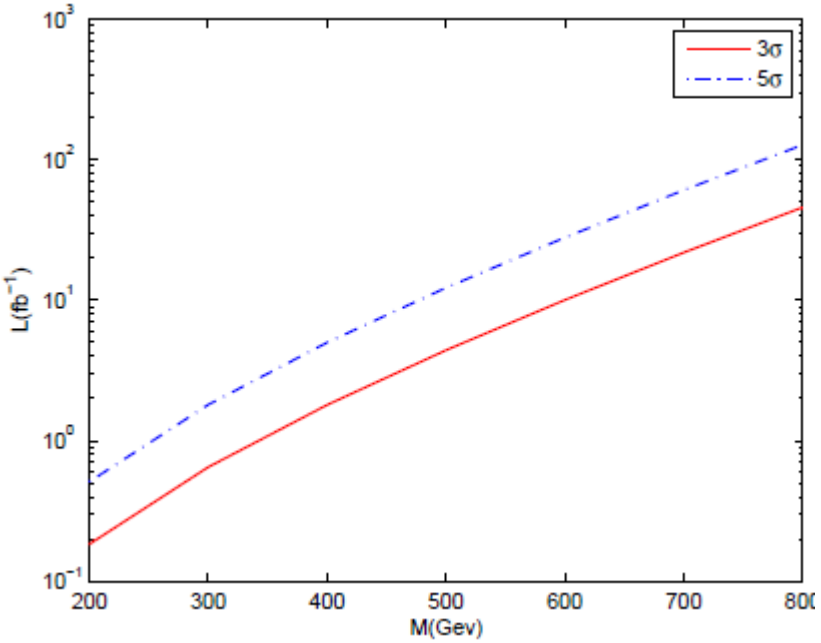
All the exotic leptons pair production and associated production processes can provide the lepton flavor changing signature:

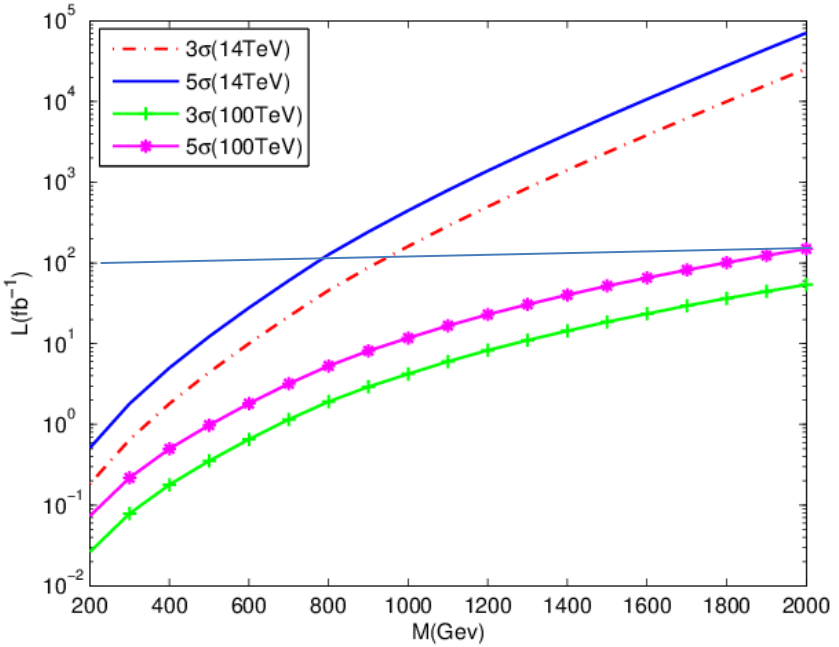
$$pp \to X^{--}X^{++} \to e^-W^-\mu^+W^+ + h.c. \to e^-\mu^+jjjj + h.c.$$

$$pp \to X^{--}X^{+} + h.c. \to e^-W^-\mu^+Z(H) + h.c. \to e^-\mu^+jjjj + h.c.$$

$$pp \to X^{-}X^{+} \to e^-\mu^+ZZ(ZH, HH) + h.c. \to e^-\mu^+jjjj + h.c.$$

Needed luminosity to observe different mass triplet leptons via lepton flavor violating processes at the LHC (left) and 100 TeV (right) collider.





Anomalous gauge couplings detection

The effective Lagrangian always has been an important model independent approach to study the new physics beyond standard model

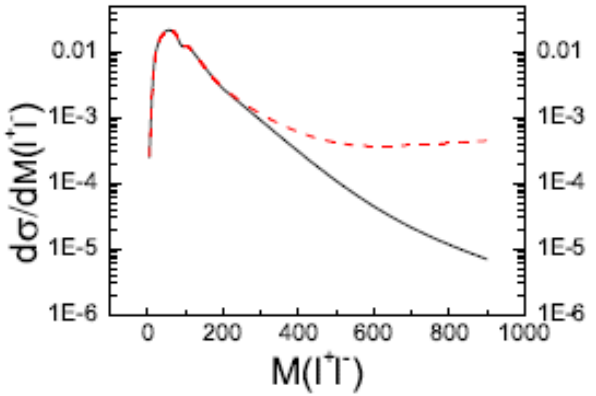
C. N. Leung, S. T. Love, and S. Rao, Z. Phys. **C31**, 433 (1986)

$$\mathcal{L}_{\rm eff} = \sum_n \frac{f_n}{\Lambda^2}\mathcal{O}_n \,,$$

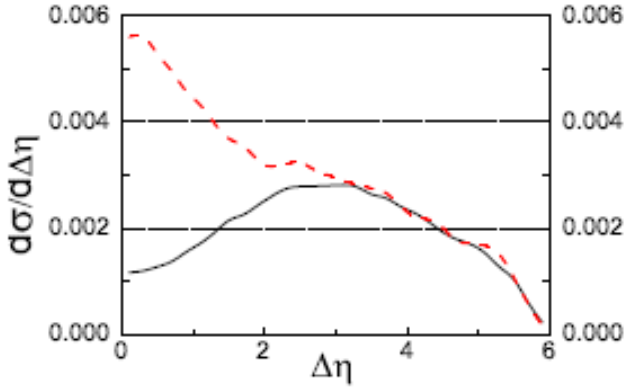
5 of all the dimension-6 operators are involved with leptonic gauge couplings and CP even

$$\begin{aligned}
\mathcal{O}_9 &= i\overline{Q}\gamma_\mu W^{\mu\nu}\overleftrightarrow{D_\nu}Q \\
\mathcal{O}_{15} &= i\overline{Q}\gamma_\mu B^{\mu\nu}\overleftrightarrow{D_\nu}Q \\
\mathcal{O}_{17} &= i\overline{U}\gamma_\mu B^{\mu\nu}\overleftrightarrow{D_\nu}U \\
\mathcal{O}_{19} &= i\overline{D}\gamma_\mu B^{\mu\nu}\overleftrightarrow{D_\nu}D \\
\mathcal{O}_{25} &= \overline{Q}\gamma_\mu D_\nu W^{\mu\nu}Q \\
\mathcal{O}_{28} &= \overline{Q}\gamma_\mu \partial_\nu B^{\mu\nu}Q \\
\mathcal{O}_{29} &= \overline{U}\gamma_\mu \partial_\nu B^{\mu\nu}U \\
\mathcal{O}_{30} &= \overline{D}\gamma_\mu \partial_\nu B^{\mu\nu}D
\end{aligned}$$

Testing the quark's anomalous couplings via W pair production at pp collider



Invariant mass of leptons



Rapidity difference of two leptons

cuts $M(l^+l^-) > 500\text{GeV}$ $\Delta\eta < 2$

	14TeV	100TeV
$\sigma_{SM}(\text{fb})$	3.4	46
$\frac{f_9}{\Lambda^2} \times 100(\text{TeV}^{-2})$	$[-1.2, 1.2]$	$[-0.082, 0.082]$
$\frac{f_{25}}{\Lambda^2} \times 10^4(\text{TeV}^{-2})$	$[-4.4, 5.4]$	$[-0.054, 0.055]$
$\frac{f_{28}}{\Lambda^2}(\text{TeV}^{-2})$	$[-1.0, 0.8]$	$[-0.33, 0.30]$
$\frac{f_{29}}{\Lambda^2}(\text{TeV}^{-2})$	$[-1.2, 1.1]$	$[-0.42, 0.37]$
$\frac{f_{30}}{\Lambda^2}(\text{TeV}^{-2})$	$[-1.5, 1.6]$	$[-0.47, 0.50]$

detection sensitivities