CMS-EXO-14-014 Validation

A.Hammad
ahammad@zewailcity.edu.eg
February 11, 2017

Title: Search for heavy Majorana neutrinos in $e^{\pm}e^{\pm}$ jets and $e^{\pm}\mu^{\pm}$ jets events in proton-proton collisions at $\sqrt{s} = 8TeV$
Luminosity: 19.7 fb^{-1}
Center of Mass Energy: 8 TeV

1 The Analysis

A search is performed for heavy Majorana neutrinos (N) decaying into a Wboson and a lepton using the CMS detector at the Large Hadron Collider. A signature of two jets and either two same sign electrons or a same sign electron-muon pair is searched for using 19.7 fb^{-1} of data collected during 2012 in proton-proton collisions at a centre-of-mass energy of 8 TeV. The data are found to be consistent with the expected standard model (SM) background.

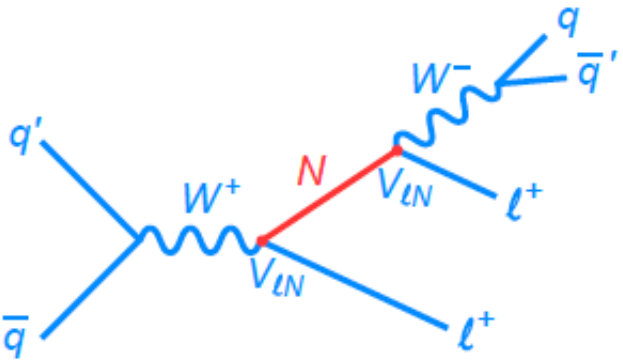

Figure 1.1: Feynman diagram for resonant production of a Majorana neutrino, where $l^{\pm}$ counts for both electrons and muons only.

2 Selection criteria for signal regions

Depending on the m_N hypothesis, signal events from heavy neutrino decays have different kinematic properties. In the low mass search region ($m_N \leq m_W$), the W boson propagator that produces the heavy neutrino is on-shell and the final state system of dileptons and two jets should have an invariant mass close to the Wmass. In the high mass search region ($m_N > m_W$), the W boson propagator is off-shell but the W boson from the heavy neutrino decay is onshell, so the invariant mass of the two jets from the W will be close to the W mass. Therefore, two different selection criteria were developed, depending on the heavy neutrino mass hypothesis to obtain the best sensitivity. For this analyses the simulated mass points are divided into low mass ($< 90GeV$) and high-mass ($> 90GeV$) search regions.

* Please be careful for the standard cuts taken by the event generator at low mass region, while the limit is very sensitive for P_T and ΔR.

3 Validation

- No cut flow is provided by CMS, validation is performed with signal regions. See plots for exclusion limit.

- Signal regions is defined according to the heavy neutrino mass which is defined as low mass region $M_N \leq M_W$ and High mass region with $M_W \leq M_N \leq 500GeV$.
- Cuts required for each signal region are in Table (2).
- Number of observed events and estimated SM background events are in Table(7)
- The validation plots have obtained for Symmetry Protected Seesaw Scenario (SPSS) model as in arXiv:1612.02728 [hep-ph]
- Signal events generated by using Whizard + pythia
- MLM merging algorithm has been used to avoid jets double counting.

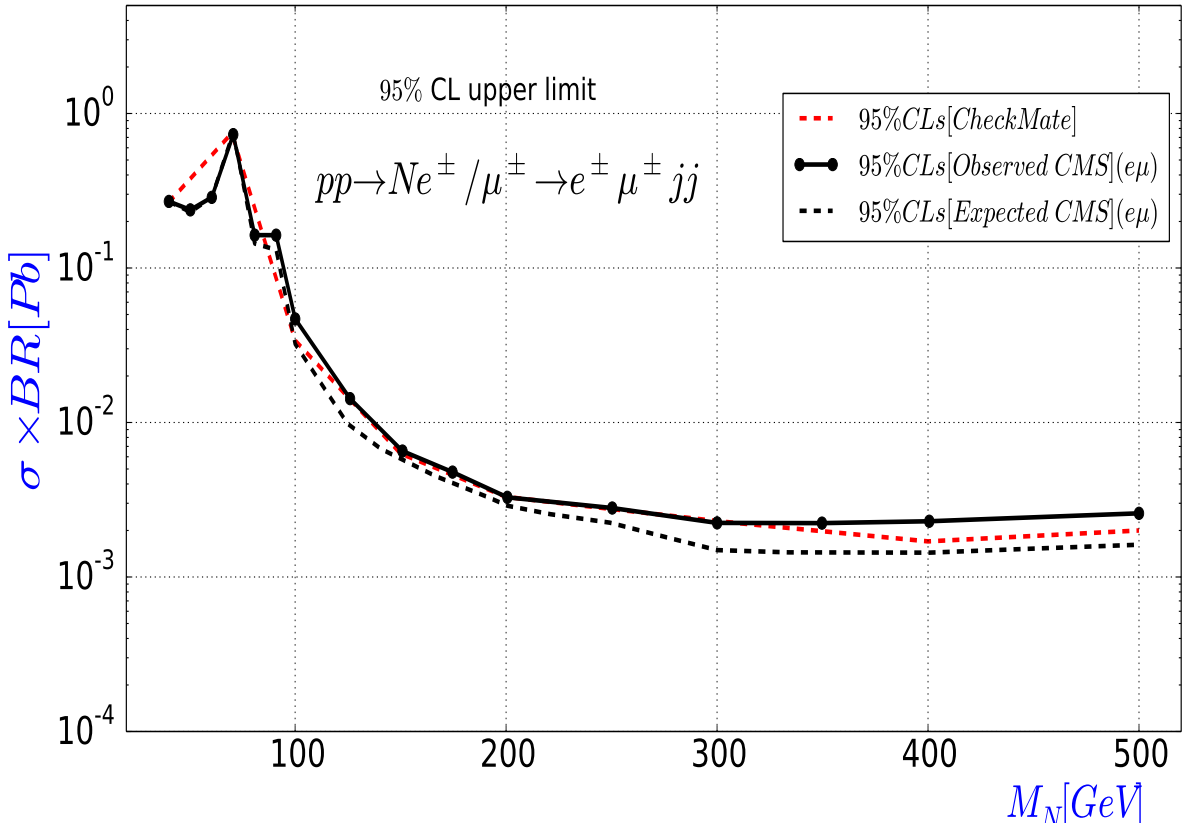

Figure 3.1: Exclusion region at 95% CL in the cross section times branching fraction for and $\sigma(pp \to Nl^{\pm} \to e^{\pm}\mu^{\pm}jj)$ (black) as a function of M_N, CheckMate result is in red. CMS data extracted by g3DATA package.

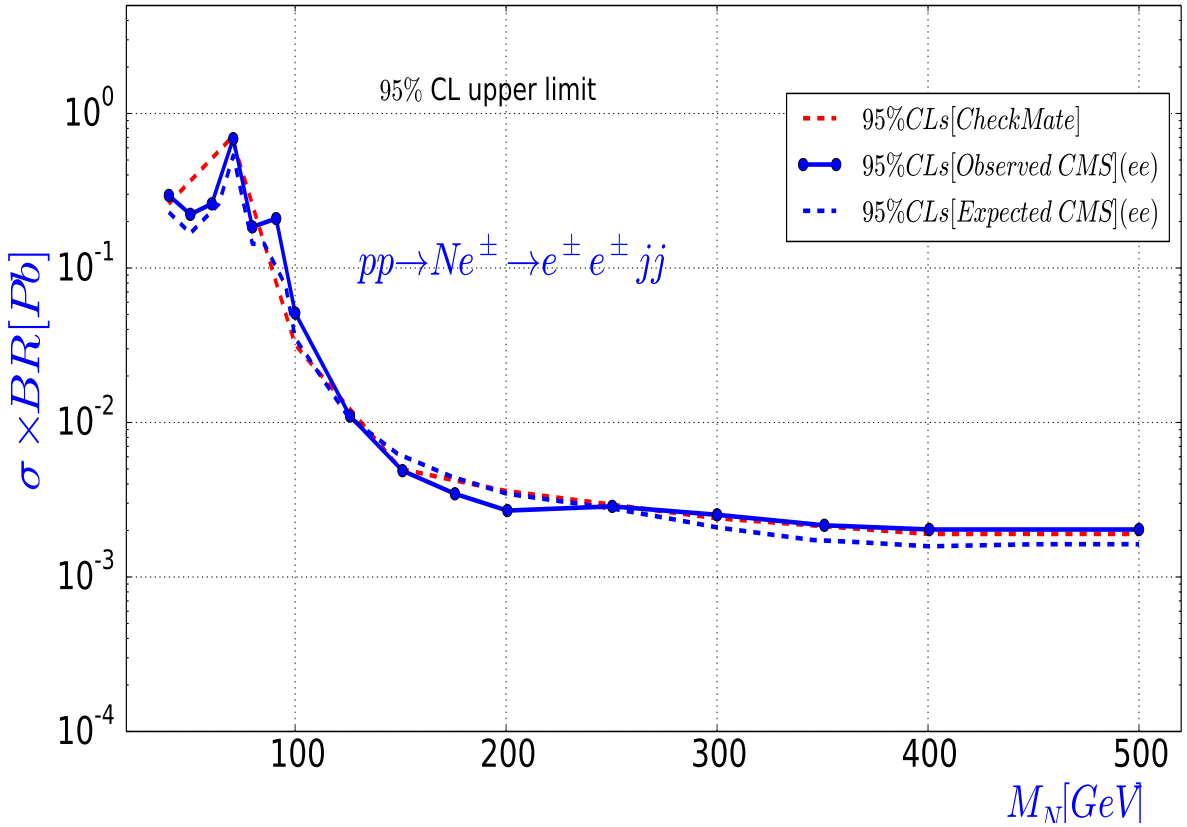

Figure 3.2: Exclusion region at 95% CL in the cross section times branching fraction for $\sigma(pp \to Nl^{\pm} \to e^{\pm}e^{\pm}jj)$ (blue) as a function of M_N, CheckMate result is in red. CMS data extracted by g3DATA package.