

In this work, we explored the possibility of using a vector boson fusion trigger in the context of a GeV-scale Type I Seesaw model. We consider a minimal model, where both Higgs and Z mediated contributions produce one heavy neutrino, as well as an extended model where the Higgs can decay into two heavy ones.

Type 1 Seesaw Lagrangian

$$\mathcal{L} = \mathcal{L}_{SM} - \bar{L}_a (Y_\nu)_{as} \nu_{R_s} \tilde{\phi} - \frac{1}{2} \bar{\nu}_{R_s}^c (M_R)_{st} \nu_{R_t} + \text{h.c.}$$

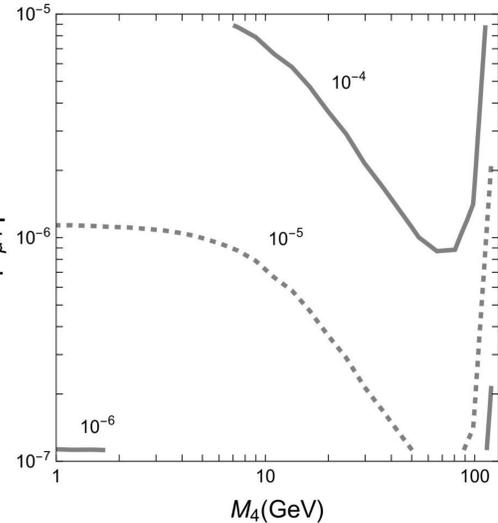
Extended Model

$$\Delta \mathcal{L} = -\frac{\lambda_{st}}{\Lambda} \bar{\nu}_{R_s}^c \nu_{R_t} \phi^\dagger \phi + \text{h.c.}$$

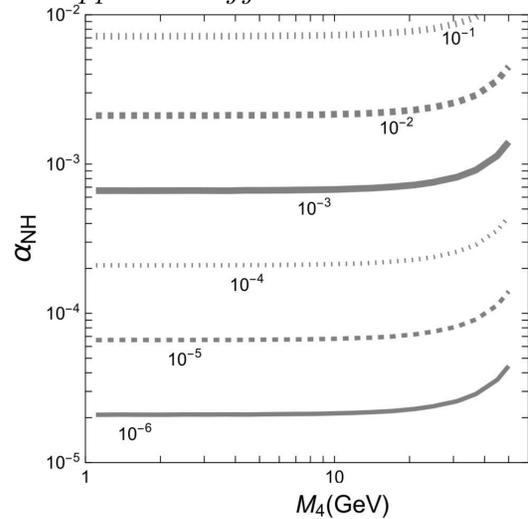
$$\mathcal{L}_{h^0 \nu_h \nu_h} = -(\alpha_{NH})_{st} \bar{\nu}_{R_s}^c \nu_{R_t} h^0 + \text{h.c.}$$

$$(\alpha_{NH})_{st} \equiv \lambda_{st} v_{SM} / \Lambda$$

VBF Cross-section(pb) for $pp \rightarrow \nu N jj$ in the Minimal Model

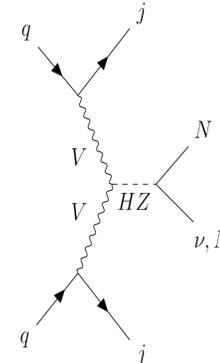


VBF Cross-section(pb) for $pp \rightarrow NN jj$ in the Extended Model



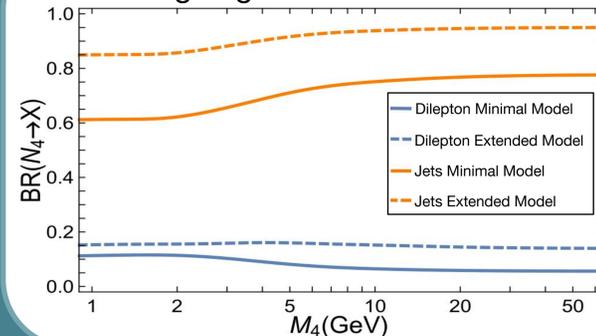
VBF diagram for studied processes. V denotes gauge bosons, and the Z only contributes in the Minimal Model

$p_T(j_1)$	> 30 GeV
$ \eta(j_1) $	< 5.0
$p_T(j_2)$	> 30 GeV
$ \eta(j_2) $	< 5.0
$\eta(j_1) \cdot \eta(j_2)$	< 0
$ \Delta\eta(j_1, j_2) $	> 4.2
$m_{j_1 j_2}$	> 750 GeV
$\sum_j p_T$	> 200 GeV

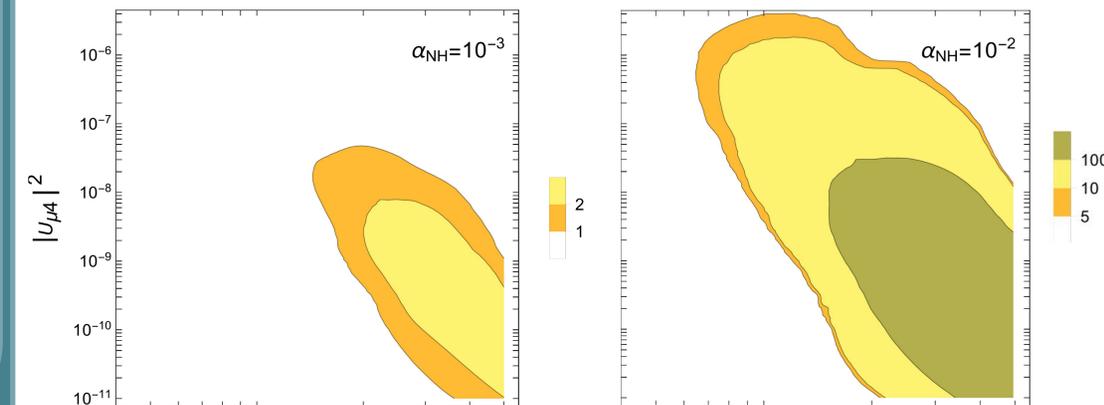


VBF trigger cuts at ATLAS and CMS^[2,3]. The cut on the sum of hadronic activity is sensible to the decay channels of N. And it is particularly relevant to this search

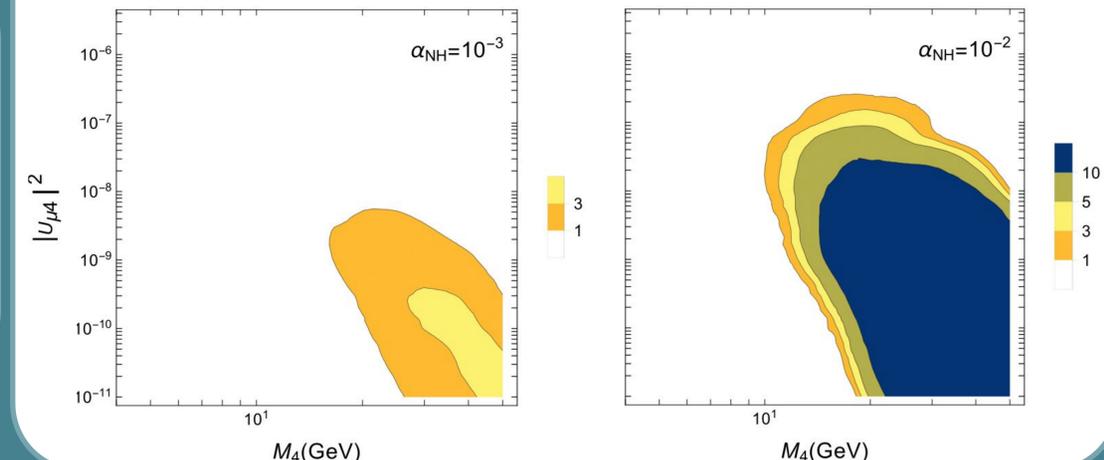
BR's for N going into final states of interest



Final number of events with displaced dilepton for $\alpha_{NH} = 10^{-3}(10^{-2})$



Sensitivity with displaced multitrack jets for $\alpha_{NH} = 10^{-3}(10^{-2})$



Cuts used for displaced dileptons search^[4]

$p_T(e)$	> 10 GeV
$p_T(\mu)$	> 8 GeV
$ \eta(\ell) $	< 2.4
$\Delta R(\mu, e)$	> 0.5
$\sqrt{L_x^2 + L_y^2}$	< 40 mm
L_z	< 300 mm

Cuts used for displaced multitrack jets search^[5]

$p_T(j_1)$	$> 25(70)$ GeV
$p_T(j_2)$	$> 25(-)$ GeV
$ \eta(j_i) $	< 4.9
# of tracks	≥ 5
m_{DV}	> 10 GeV
$ d_0 $	> 2 mm
$(\sqrt{L_x^2 + L_y^2})_{\min}$	4 mm.
$(\sqrt{L_x^2 + L_y^2})_{\max}$	300 mm.
$ L_z $	< 300 mm.

Both scenarios are tested through displaced dilepton and displaced multitrack jet searches. Using the VBF topology we modified the original triggers described in the references. In the Minimal Model the number of surviving events was negligible, so we opted for the Extended Model in which production and decay are decoupled. For the displaced multitracks jets search we were able to estimate the new background, so we present the sensitivity. For both searches the only background is instrumental.

[1] J. Jones, J. Masias, J. Ruiz. Search for Long-Lived Heavy Neutrinos at the LHC with a VBF Trigger. arXiv:1912.08206 [hep-ph] (2017).

[2] CMS Collaboration, V. Khachatryan et al., "Search for the standard model Higgs boson produced through vector boson fusion and decaying to bb ," Phys. Rev. D92 no. 3, (2015)

[3] ATLAS Collaboration, "Trigger menu in 2018," Tech. Rep

[4] CMS Collaboration, C. Collaboration, "Search for displaced leptons in the e-mu channel", (2016)

[5] ATLAS Collaboration, M. Aaboud et al., "Search for long-lived, massive particles in events with displaced vertices and missing transverse momentum in $\sqrt{s} = 13$ TeV pp collisions with the ATLAS detector," Phys. Rev. D97 no. 5, (2018) 052012