

HNL model	Selection	Categories	OSSF	Fitted distributions
(10–40 GeV, e)	low mass	$0\tau_h$	no	La1–8
		$0\tau_h$	yes	BDT(10–40, e, $0\tau_h$)
(40–75 GeV, e)	low mass	$0\tau_h$	no	La1–8
		$0\tau_h$	yes	BDT(50–75, e, $0\tau_h$)
(85–125 GeV, e)	high mass	$0\tau_h$	any	BDT(85–150, e, $0\tau_h$)
(125–250 GeV, e)	high mass	$0\tau_h$	any	BDT(200–250, e, $0\tau_h$)
(250–400 GeV, e)	high mass	$0\tau_h$	any	BDT(300–400, e, $0\tau_h$)
(≥ 400 GeV, e)	high mass	$0\tau_h$	any	Ha1–9, Hb1–16
(10–40 GeV, μ)	low mass	$0\tau_h$	no	La1–8
		$0\tau_h$	yes	BDT(10–40, μ , $0\tau_h$)
(40–75 GeV, μ)	low mass	$0\tau_h$	no	La1–8
		$0\tau_h$	yes	BDT(50–75, μ , $0\tau_h$)
(85–125 GeV, μ)	high mass	$0\tau_h$	any	BDT(85–150, μ , $0\tau_h$)
(125–200 GeV, μ)	high mass	$0\tau_h$	any	BDT(200–250, μ , $0\tau_h$)
(200–400 GeV, μ)	high mass	$0\tau_h$	any	BDT(300–400, μ , $0\tau_h$)
(≥ 400 GeV, μ)	high mass	$0\tau_h$	any	Ha1–9, Hb1–16
(10–40 GeV, τ)	low mass	$0\tau_h$	no	La1–8
		$0\tau_h$	yes	BDT(10–40, τ , $0\tau_h$)
		$1\tau_h$	no	La1–8
		$1\tau_h$	yes	BDT(10–40, τ , $1\tau_h$)
(40–75 GeV, τ)	low mass	$0\tau_h$	no	La1–8
		$0\tau_h$	yes	BDT(50–75, τ , $0\tau_h$)
		$1\tau_h$	no	La1–8
		$1\tau_h$	yes	BDT(50–75, τ , $1\tau_h$)
(≥ 85 GeV, τ)	high mass	all	any	Ha1–9, Hb1–16