

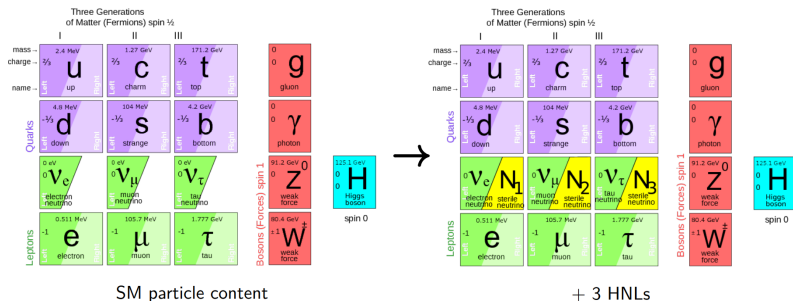
Searches for heavy neutral leptons

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- Idea of HNLs: add **right-handed** counterparts N to active neutrinos ν_α



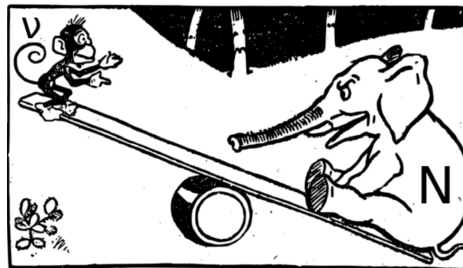
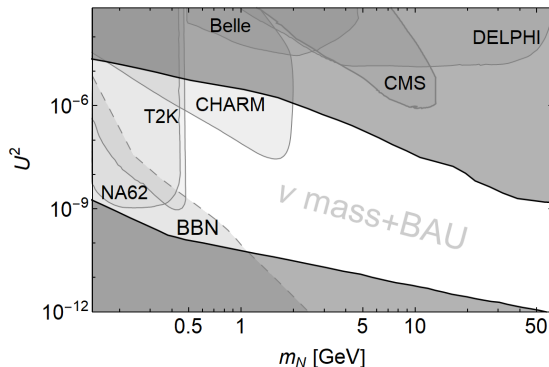
- (Minimal) Lagrangian:

$$\mathcal{L}_{\text{HNL}} = Y_\alpha \bar{L}_\alpha \tilde{H} N + \text{h.c.} + \text{kin. terms} \quad (1)$$

- After SSB: HNLs behave as **heavy** ν_α with couplings suppressed by **mixing angle** $U_\alpha \ll 1$

HNLs and BSM problems

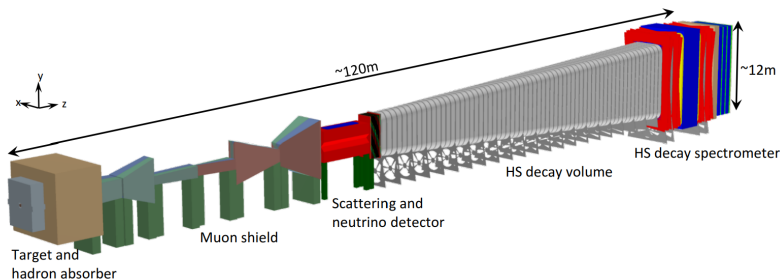
- A minimal model - ν MSM: 3 HNLs that solve BSM problems: ν_α oscillations, BAU, dark matter



HNL parameter space:

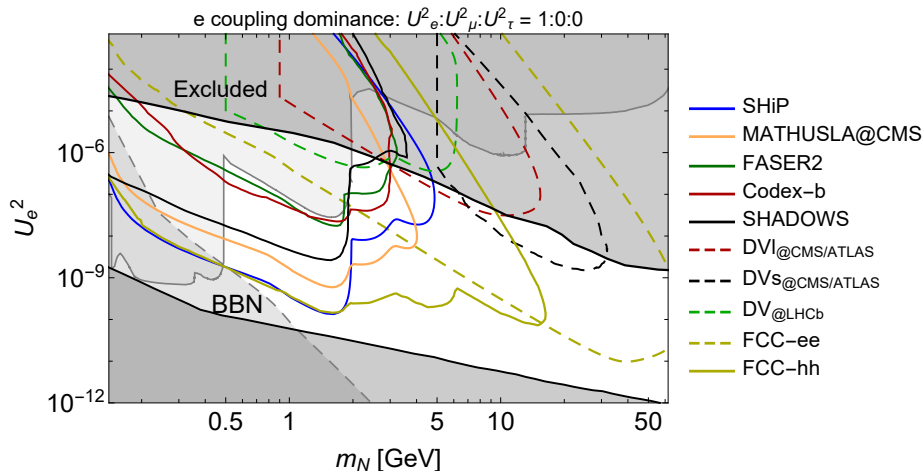
- **Large U^2 :** constrained by past experiments and impossibility of BAU
- **Small U^2 :** ruled out by cosmology and impossibility to provide masses to neutrinos

Search for HNLs



- HNLs are unstable \Rightarrow search for prompt and displaced decays of HNLs
- Best conditions: **(1)** large events intensity, **(2)** low (zero) background, **(3)** ability to reconstruct all parameters
- A perfect proposed experiment that meets these conditions – **SHiP** (to be located at SPS)

Future searches for HNLs: landscape



[2203.08039], [2204.01622], [2209.14870], [2203.05502]

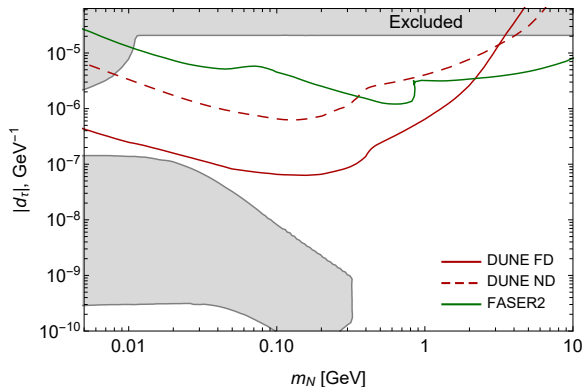
- Combination of SHiP, LHC and (later) FCC-ee/hh would push the parameter space

Non-minimal models

- HNLs may also interact with ν_α and photons via dipole coupling:

$$\mathcal{L}_{\text{dipole}} = d_\alpha \bar{L}_\alpha \sigma^{\mu\nu} N F_{\mu\nu} \quad (2)$$

- Such interactions may be probed at ν factories



In preparation