Heavy Neutrinos at Future Linear e^+e^- Colliders

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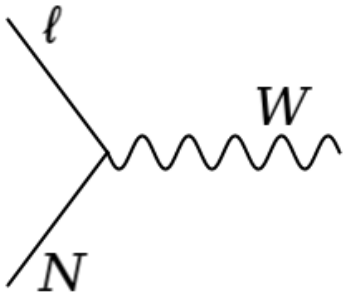
The Standard Model with heavy neutrinos

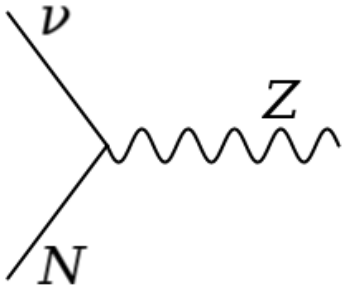
To solve some problems of SM (DM, baryon asymmetry), one can introduce new species of neutrinos:

$$\mathcal{L} = \mathcal{L}_{SM} + \mathcal{L}_{N} + \mathcal{L}_{W-N-l} + \mathcal{L}_{Z-N-\nu} + \mathcal{L}_{H-N-\nu}$$

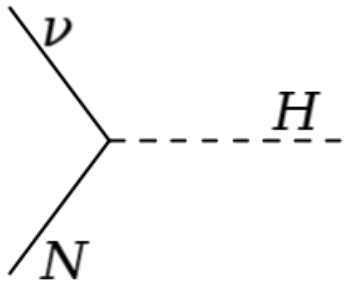
$\mathcal{L}_{W-N-l}$



$\mathcal{L}_{Z-N-\nu}$



$\mathcal{L}_{H-N-\nu}$

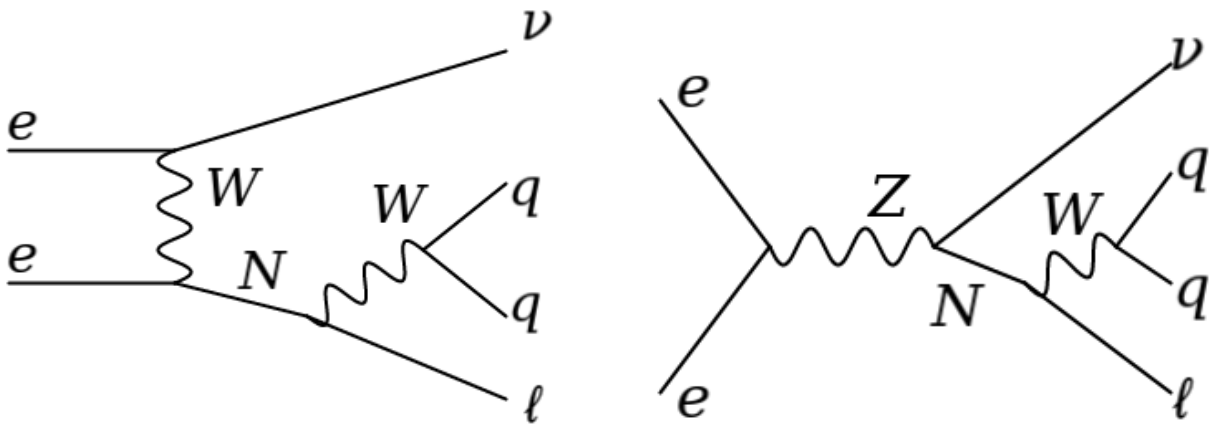


Minimal scenario – without additional gauge bosons

Heavy neutrino signature at e^+e^- colliders

Such neutrinos could be observed at e^+e^- colliders: both directly ($qql\nu$, $qq\nu\nu$, ...) and indirectly (EWPOs, ...).

The most promising signature is $qql\nu$, as it allows for reconstruction of N.



Future e^+e^- colliders

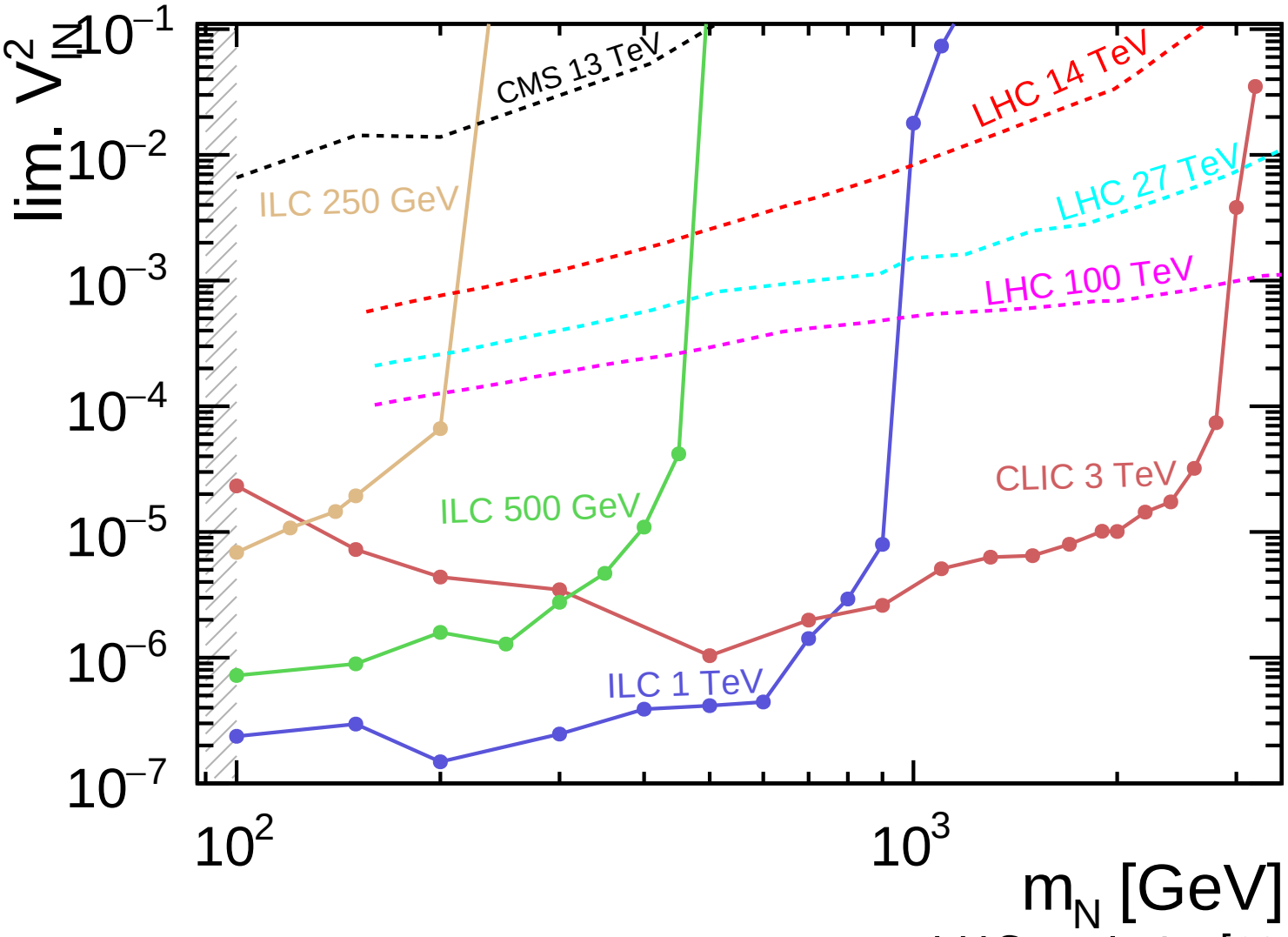
Our setup

- Dirac and Majorana neutrinos
- one heavy neutrino:

$$m_N \longrightarrow 10^2 - 10^3 \text{ GeV}$$
$$|V_{eN}|^2 = |V_{\mu N}|^2 = |V_{\tau N}|^2 \equiv V_{lN}^2$$

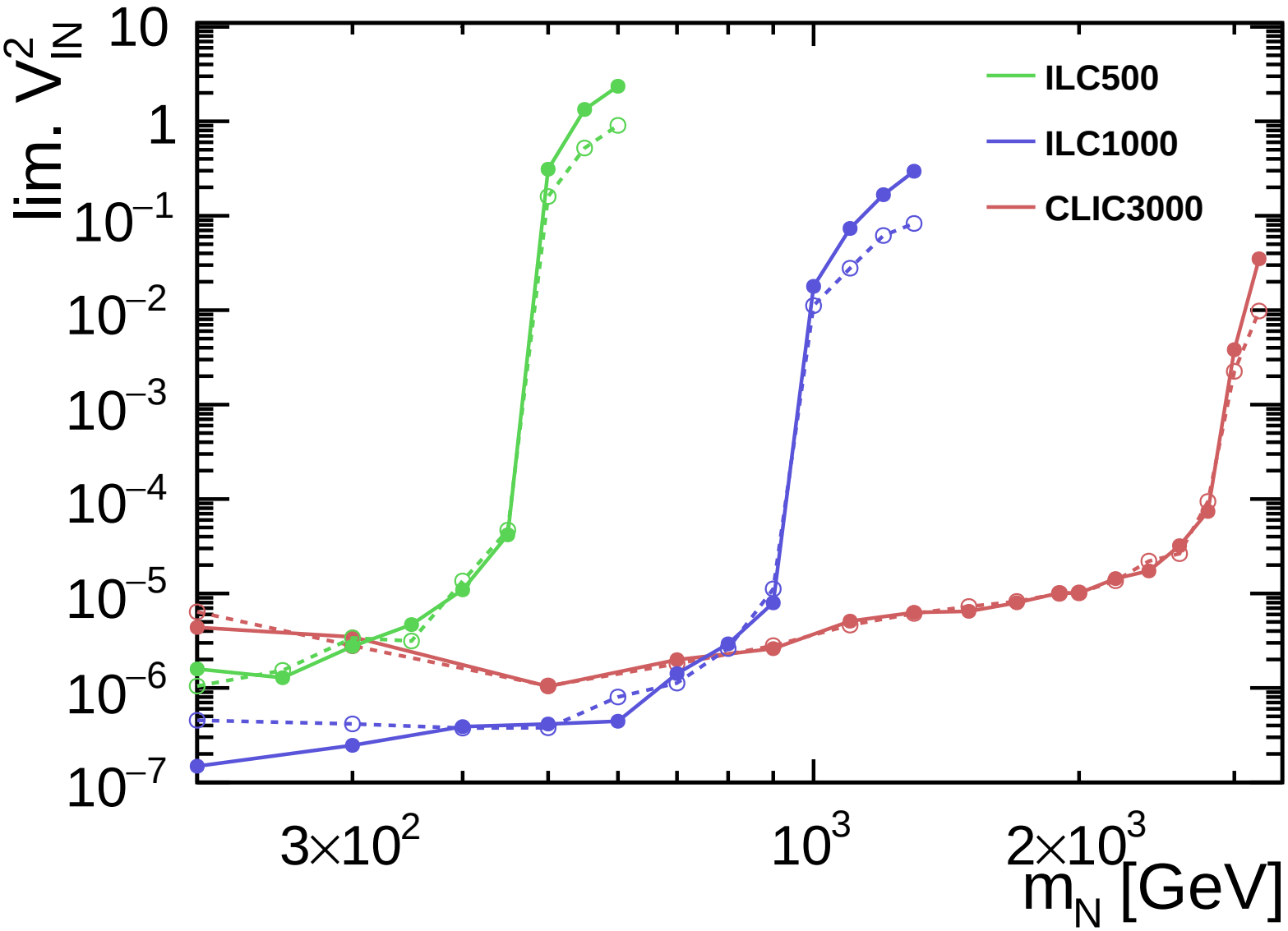
Results

The cross section limits can be translated into limits on the V_{lN}^2 parameter.

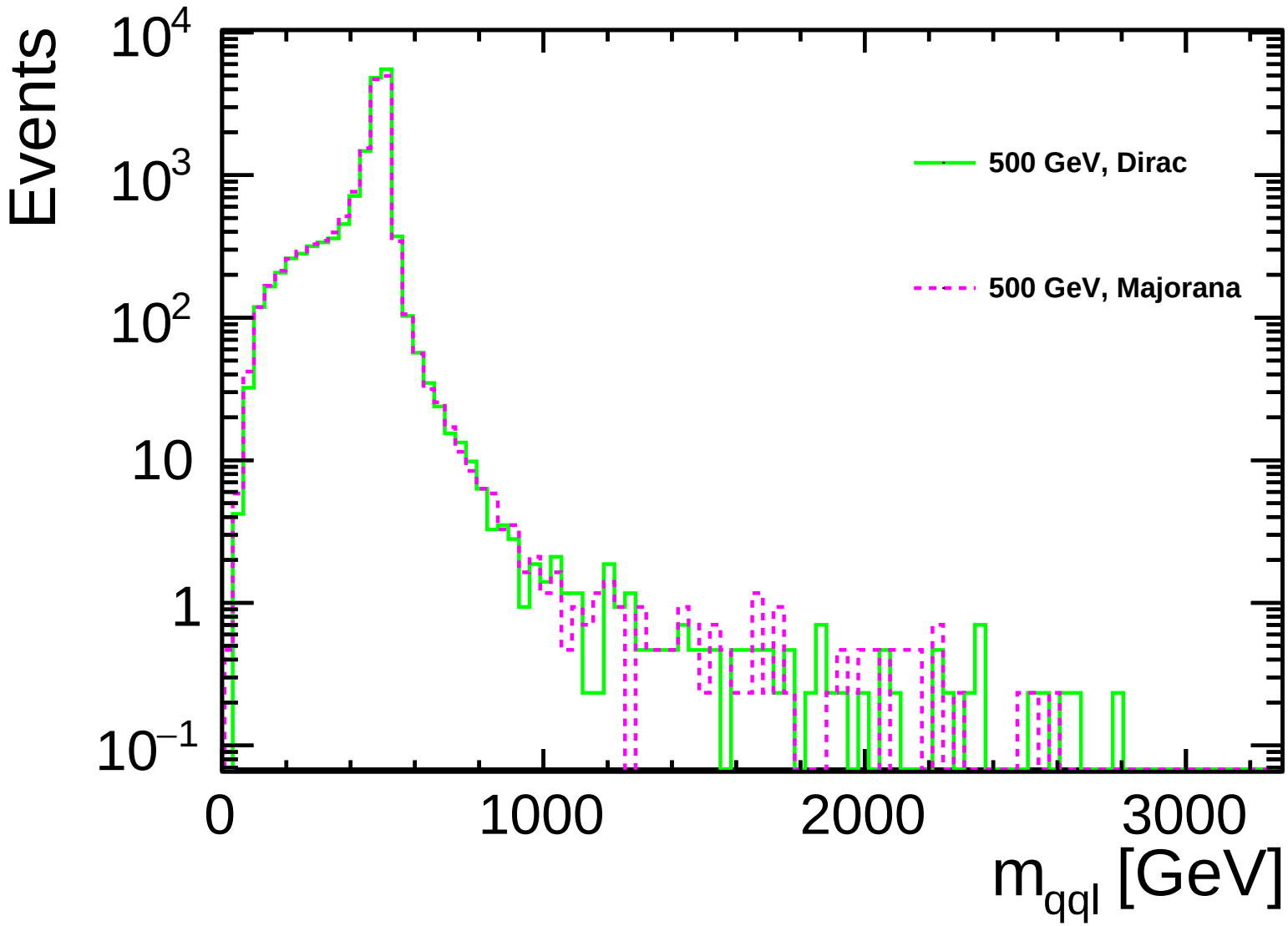


LHC analysis: [1812.08750]

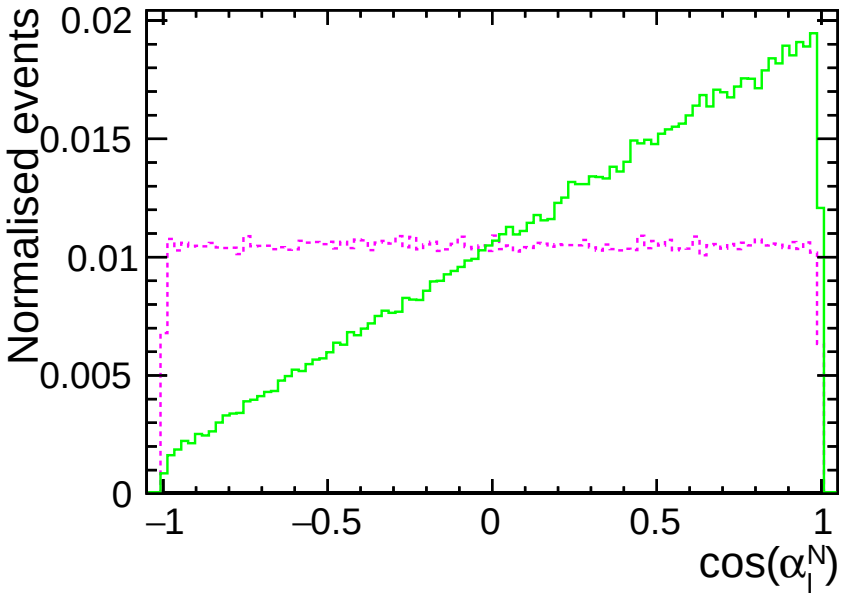
What about Majorana...?

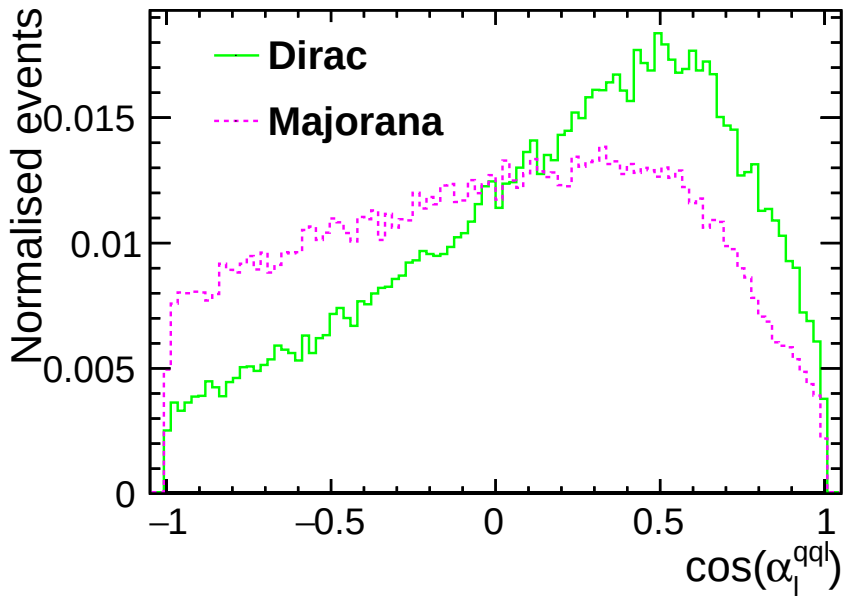


Dirac vs. Majorana – *qql* invariant mass



Dirac vs. Majorana – / emission angle





generator vs. detector

Conclusions

1. At future e^+e^- colliders, heavy neutrino production could be observed almost up to the kinematic limit.
2. The expected coupling limits are much stronger than those at LHC/FCC-hh.
3. Discrimination between the Majorana and Dirac natures of the heavy neutrino requires further studies.