BSM searches: HNL → μjj'

Status and prospects

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https://indico.cern.ch/event/1456117/

Sensitivity

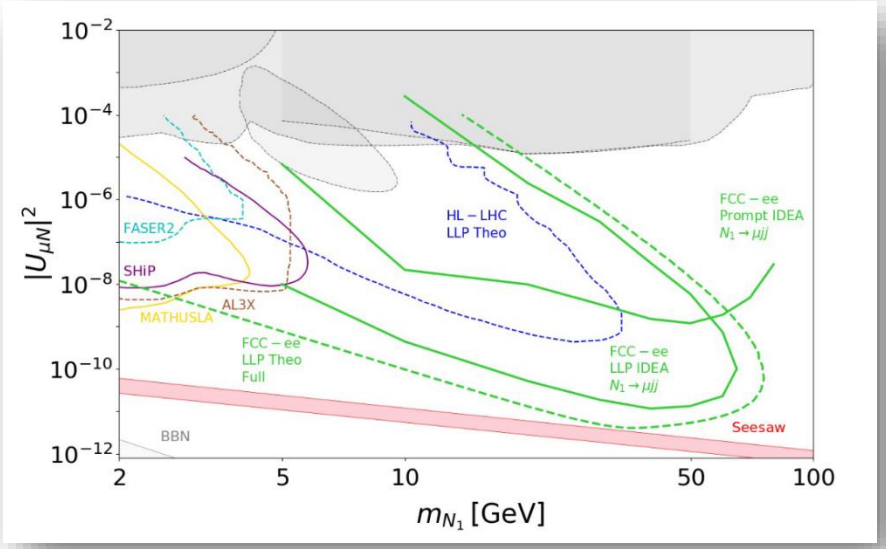
We've been focused on both the potential for discovery and the determination of the structure of the model

Channel: $Z \to N\nu,\ N \to \mu jj$

- Branching fraction ~ 50%
- HNL momentum and missing momentum fully reconstructable

Analysis note with exclusion limits: https://doi.org/10.17181/9pc9x-kcn56 (Sept 2023)

- Single neutrino model
  - Parameters: U_μ, m_{HNL}
- MG/Pythia + DELPHES IDEA fast-sim. Winter2023, bacgkround included
- HNL-ν mixing angle: exclusion limits both for a prompt and long-lived analysis
- Preliminary insight on jet resolution requirements



Next:

- "Cut and count" selection mainly built for prompt analysis. It can be to optimized while maintaining negligible background in the displaced regime
- Implementing BDT approach (XGB) → fair comparison and integration with electron analyses (Sarah, Geneva group)

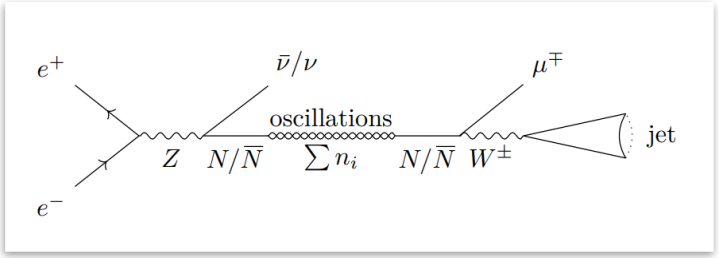
Mass resolution

Timing-based mass measurement

- Same benchmark and channel
- Nice proof-of-concept: mass resolution at the percent level with timing precision of O(40 ps)
- arXiv.2406.05102 (with R. Aleksan and E. Perez)

N-$\overline{\text{N}}$ oscillation (1/2)

Model: arXiv/2210.10738



Theoretical expectations implemented in FCCee setup and IDEA simulation. Oscillation detection based on:

1. Forward/backward asymmetry of the muon final state
   - It relies on the Z polarization
   - Presented in Annecy (link) and partially at ICHEP (link)

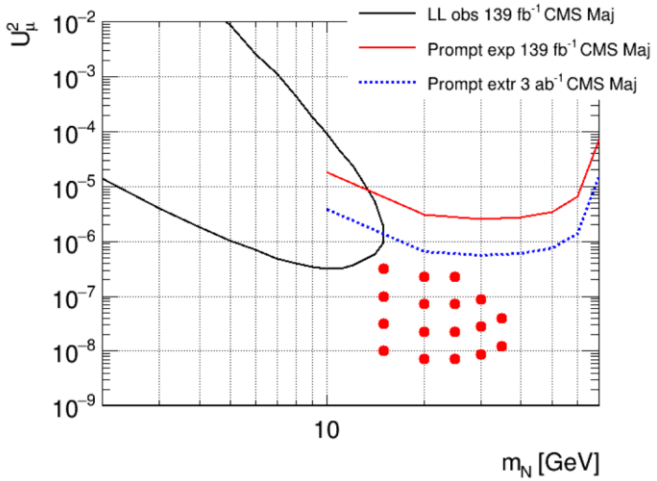
...

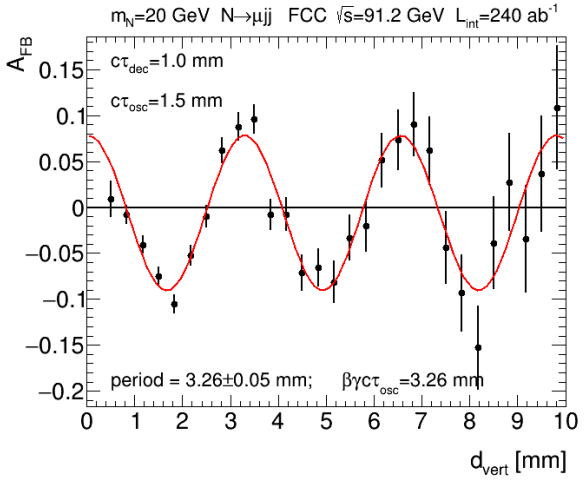
N-$\overline{\text{N}}$ oscillation (2/2)

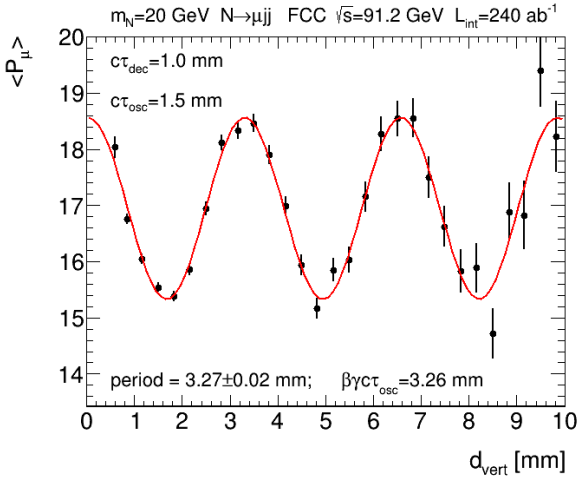
Theoretical expectations implemented in FCCee setup and IDEA simulation. Oscillation detection based on:

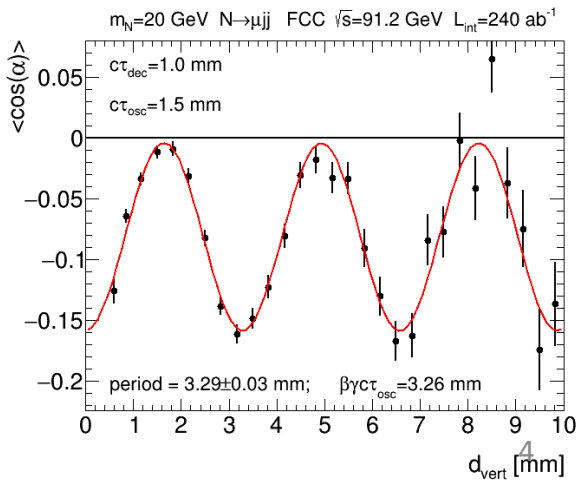
2. *New*: Angle between muon and missing momentum (in the HNL rest frame)
3. *New*: Muon momentum (in the lab frame)

- Proposed recently in https://arxiv.org/abs/2408.01389
- Reconstructed in the detector with a scan over the $U_\mu - \tau_{osc}$ parameter space









Backup

Progressing…

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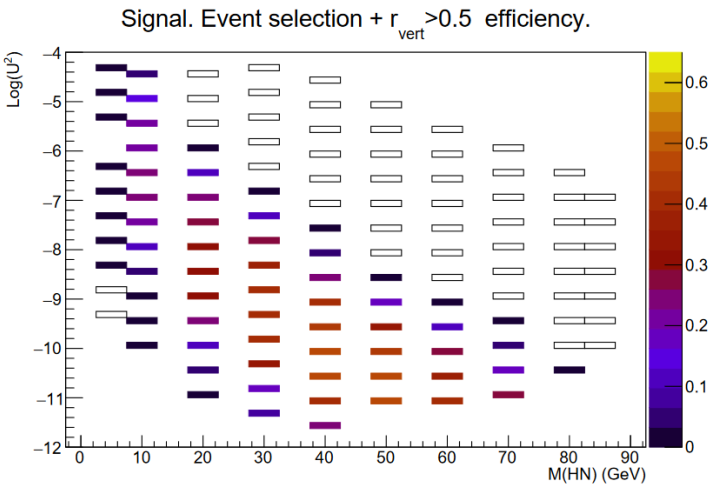
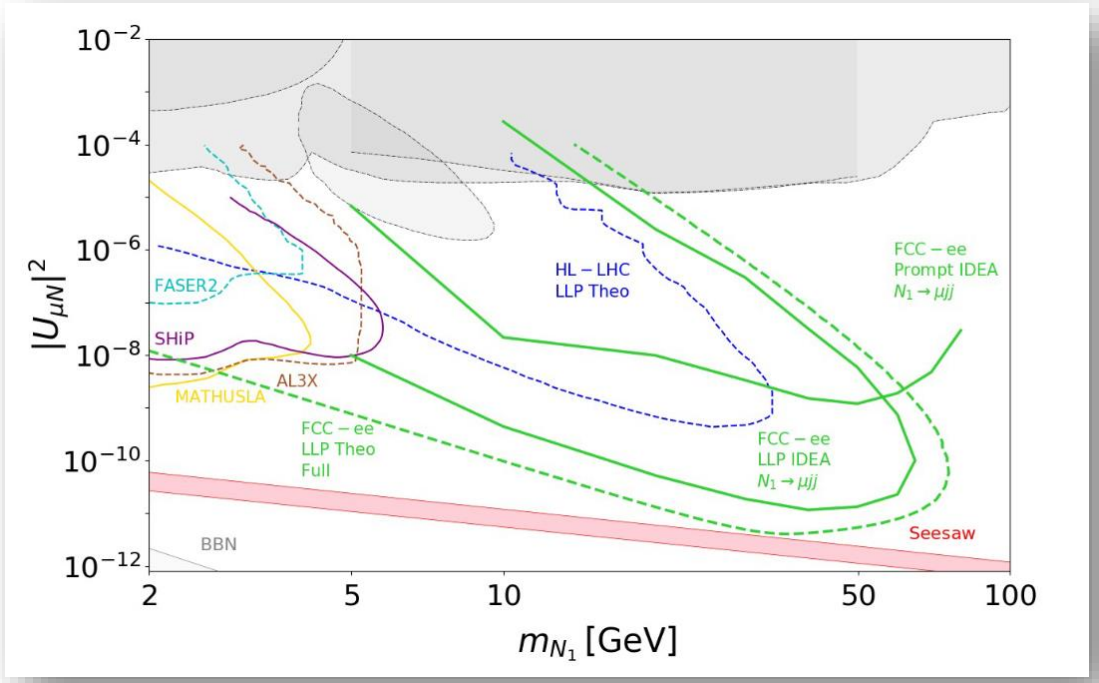
Channel: $Z \to N\nu,\ N \to \mu jj$

1. Event Filter	2. Event Selection	3. Vertex selection
1 muon ≥ 3 tracks $E_\mu \geq 3$ GeV $E_{miss} \geq 5$ GeV	1 lepton (muon) Cuts on p_{miss}, jets, μ and visible mass	$N_{tracks} - N_{tracks}^{primary} < 5$ $\chi^2_{vtx,primary} < 10$
4. Mass-dependent kin. selection	**5a. Displacement: prompt**	**5b. Displacement: LL**
M_{vis} within $2 \times 10\%\sqrt{M}$ E_{miss} within $2 \times 10\%\sqrt{p_\nu}$	$r_{vert}^{primary} > 0.5$ mm $D_{0,\mu} < 8\sigma$ if $M_{N_1} > 70$	$r_{vert}^{primary} < 0.5$ mm





Progressing…

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Potential capability to measure τ_{osc} at the percent level, depending on the value of the coupling