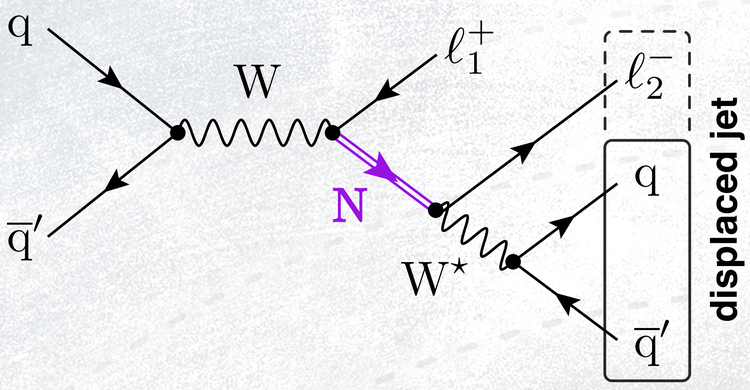
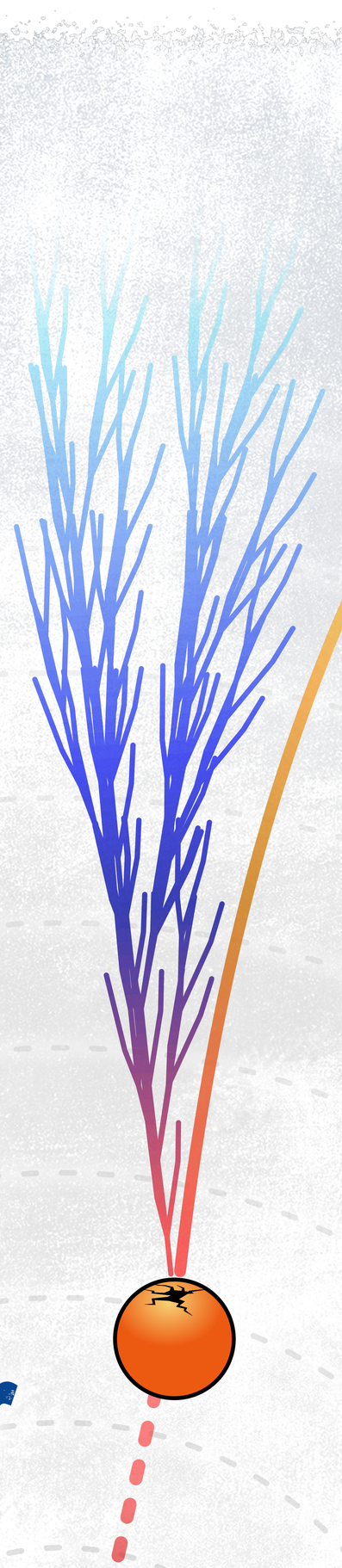
# Motivation

- heavy neutral leptons (**HNL**s) predicted through see-saw extension of SM
- HNLs mix arbitrary with SM neutrinos (couplings: $V_{\mathrm{eN}}, V_{\mu\mathrm{N}}, V_{\tau\mathrm{N}}$)
- can be **long-lived**: $\tau \propto m_{\mathrm{N}}^{-5} |V_{\ell\mathrm{N}}|^{-2}$
- displaced quarks (+ lepton) collimated in single anti-$k_{\mathrm{T}}$ jet (R=0.4)



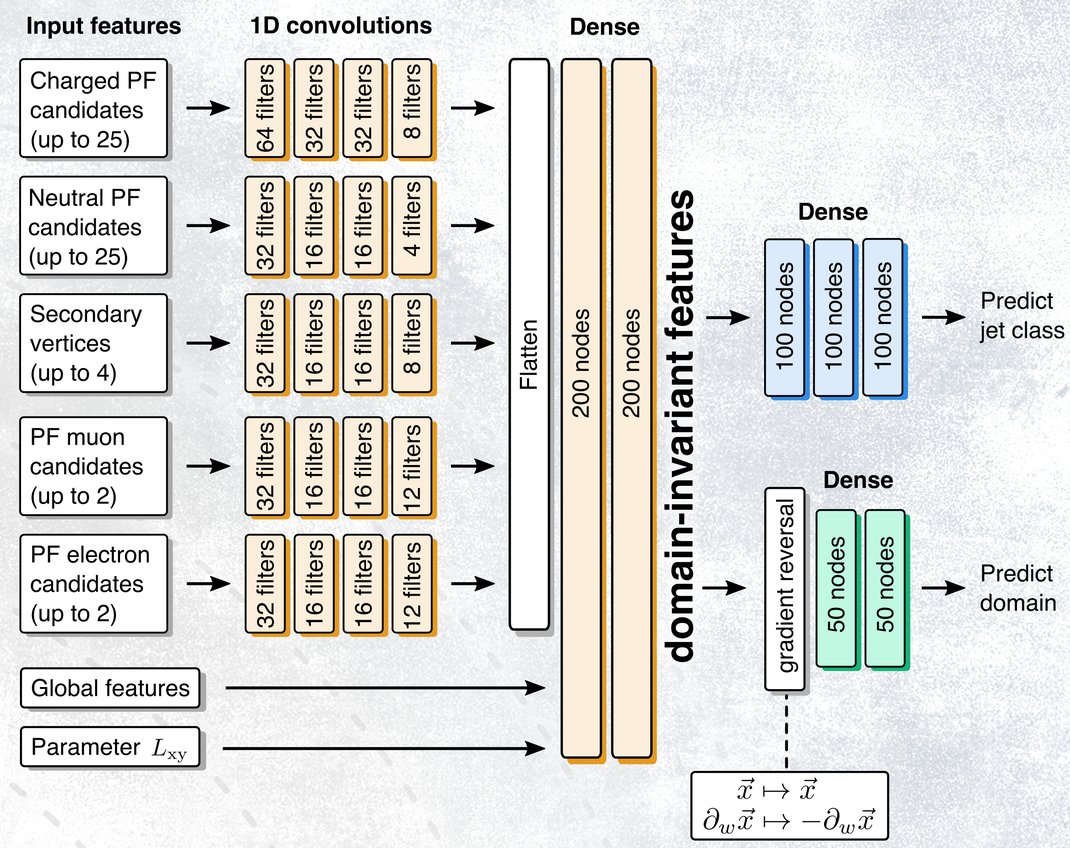
Search for long-lived heavy neutral leptons using a

# Displaced Jet Tagger

by **Matthias Komm** (DESY)

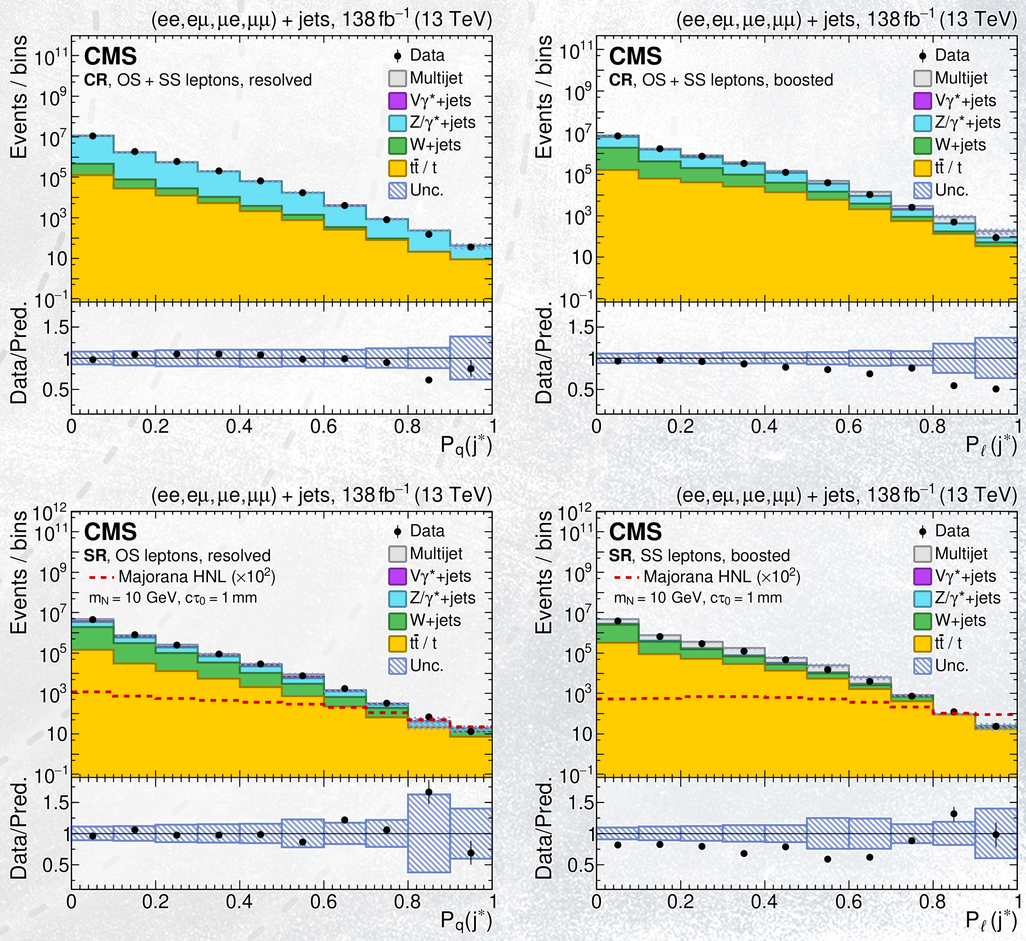
# Neural network setup

- inputs: global jet features & constituent features
- **parametrized** wrt. transverse HNL displacement $L_{\mathrm{xy}}$
- object tagger; trained against SM jet classes: prompt leptons/photons, quark/gluon jets, pileup
- uses **domain adaptation** by backpropagation $L = L_{\mathrm{class}}(\text{cross entropy}) + \lambda L_{\mathrm{domain}}(\text{Wasserstein distance})$ to enforce similar performance in data & simulation (domain = simulation or data) **(arXiv: 1912.12238)**



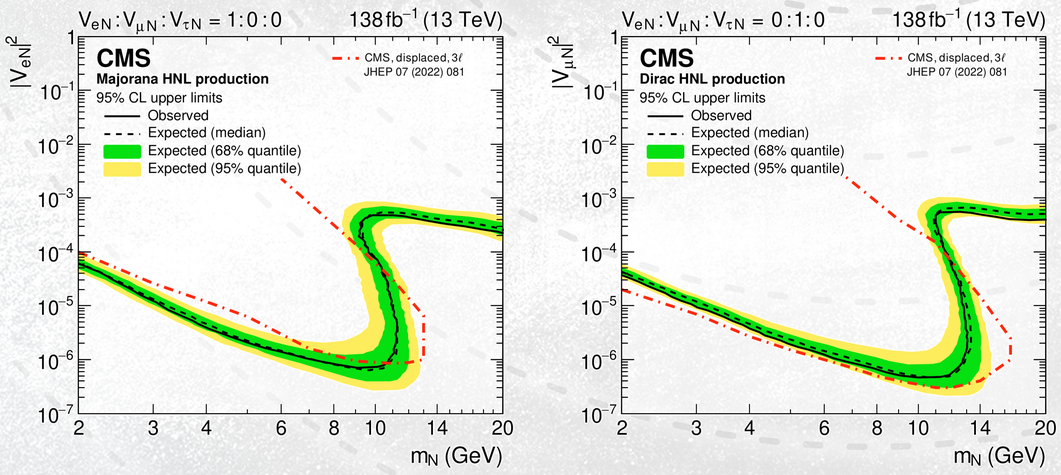

# Performance

- good modelling of data in $\mathrm{Z}/\gamma^{\star}$+ jets dominated control region & signal region ($20 < m_{\ell\ell} < 80$ GeV)
- background rejected by **several orders** $\mathcal{O}(10^{-3})$ while retaining 10-20% of signal

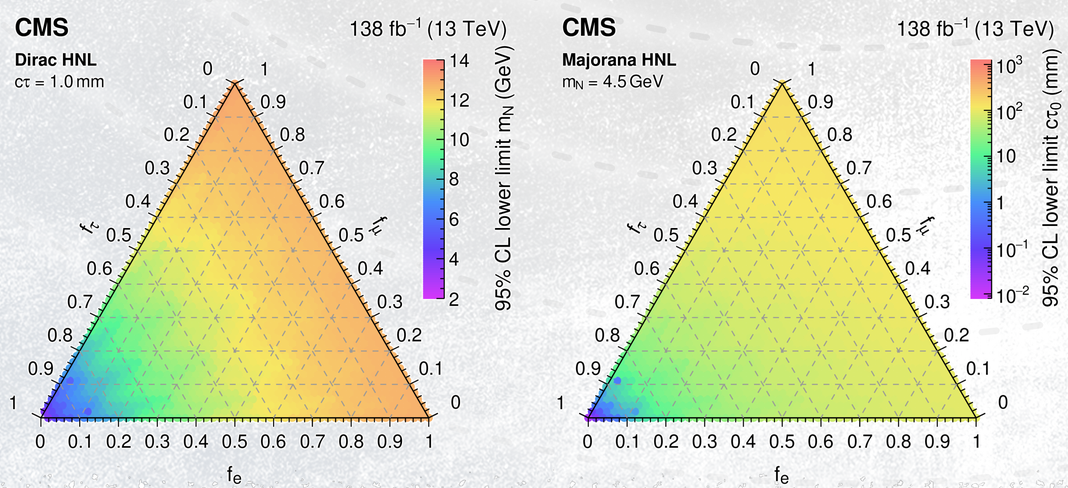



# Results

- events categorized per lepton flavour & charge combinations, boosted or resolved HNL jet & $d_{xy}^{\mathrm{sig}}(\ell_2)$ bin
- background estimated from data (ABCD method)
- no excess found; 2D limits in mass-coupling plane derived




- limits on HNL mass or lifetime in relative coupling space




# Further information

**CMS Collaboration**,
*Search for long-lived heavy neutral leptons with lepton flavour conserving or violating decays to a jet and a charged lepton* **(arXiv: 2312.07484)**