

Looking for leptophilic Z' at the FCC-ee

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In collaboration with

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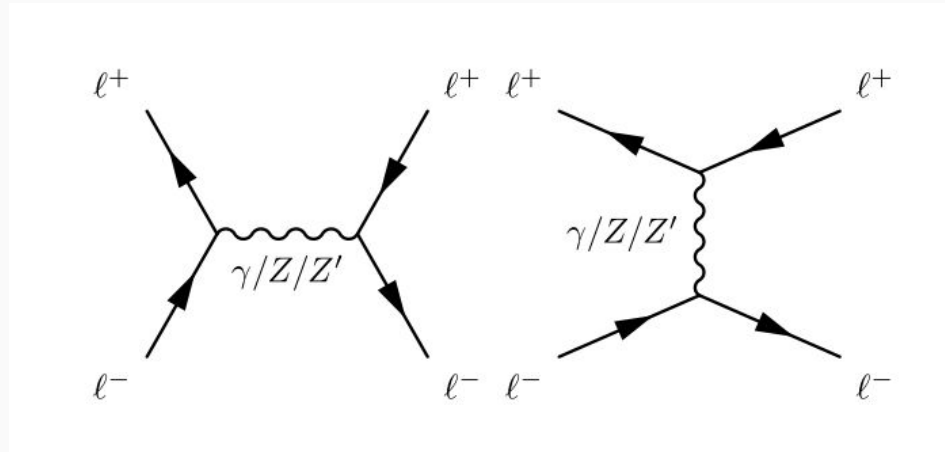
Contents

- Motivation
- Improvement on LHC bounds?
- FCC-ee potential
- What's next?

Leptophilic Z'

- Arises from an additional U(1) symmetry
- Electrically neutral, couples only to SM leptons
- Does not show up as a resonance at hadron colliders
- We focus on Le-Lmu and Le-Ltau models (models where Z' couples only to electrons and muons, and electrons and taus respectively)

See Dasgupta et al (2308.12804), Goudelis et al (2312.14103)

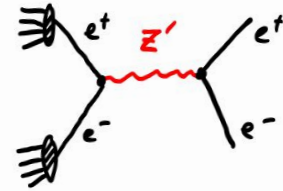


Lot of parameter space to be explored!

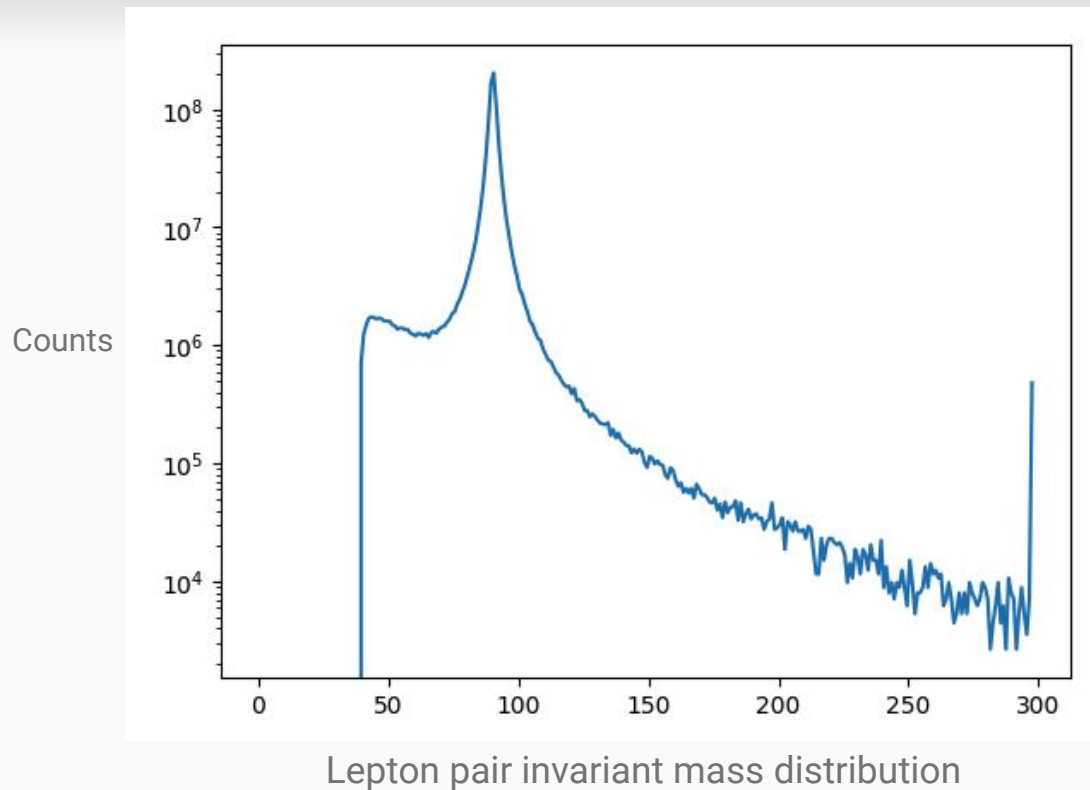


Improvement on LHC limits?

- Leptons PDF from the proton (Nason et al:JHEP 08 (2020) 08, 019)
- Incorporating LUXPDF allows us to treat LHC as a “lepton collider”
- Typical cross-sections: order $1\text{e-}6$ pb
- Background too high : no significance in unconstrained parameter space (plot in next slide)
- More statistics needed!

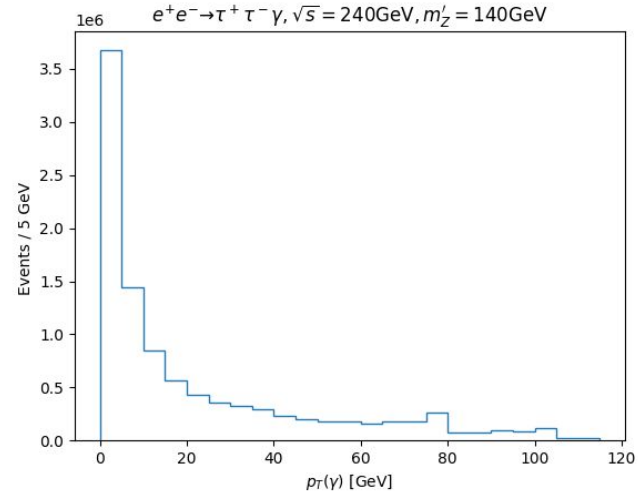
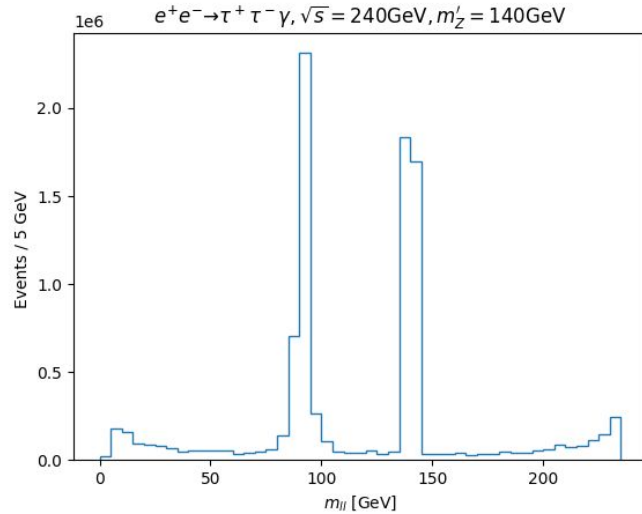
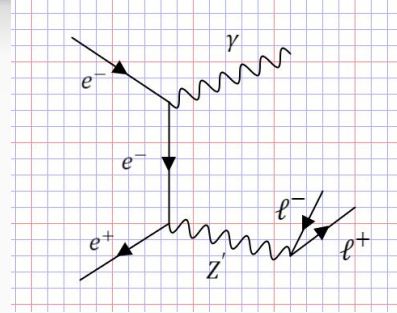


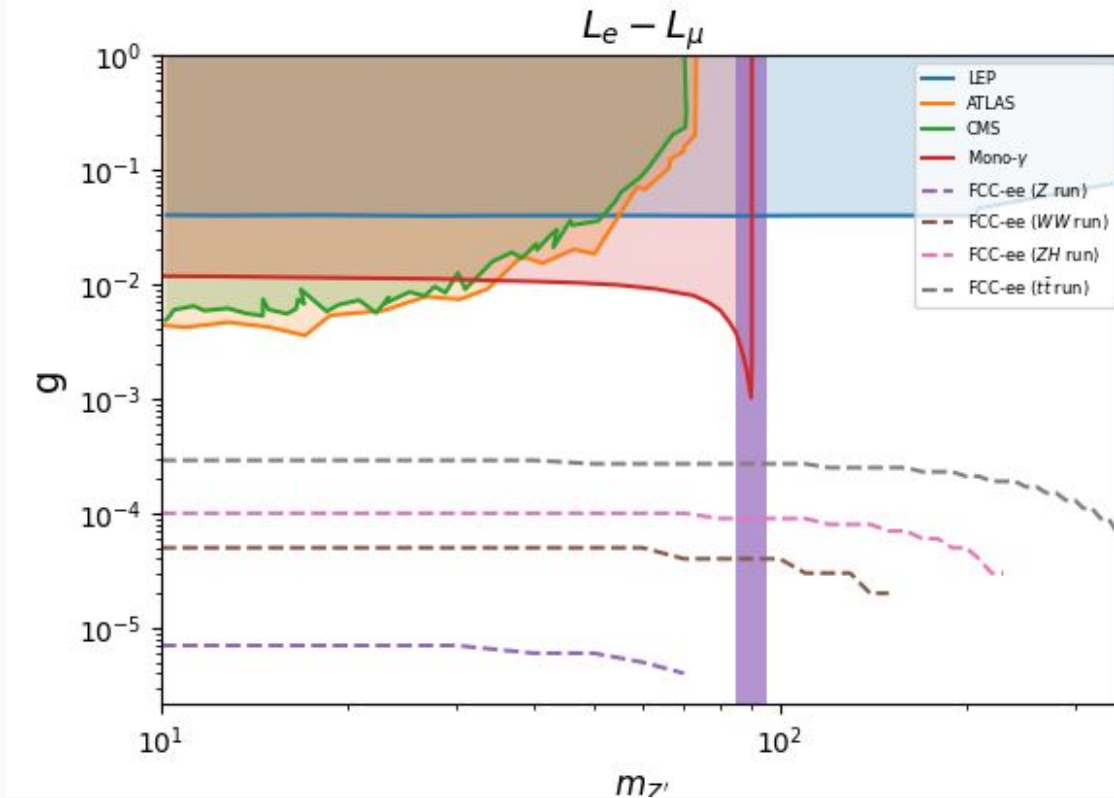
Background



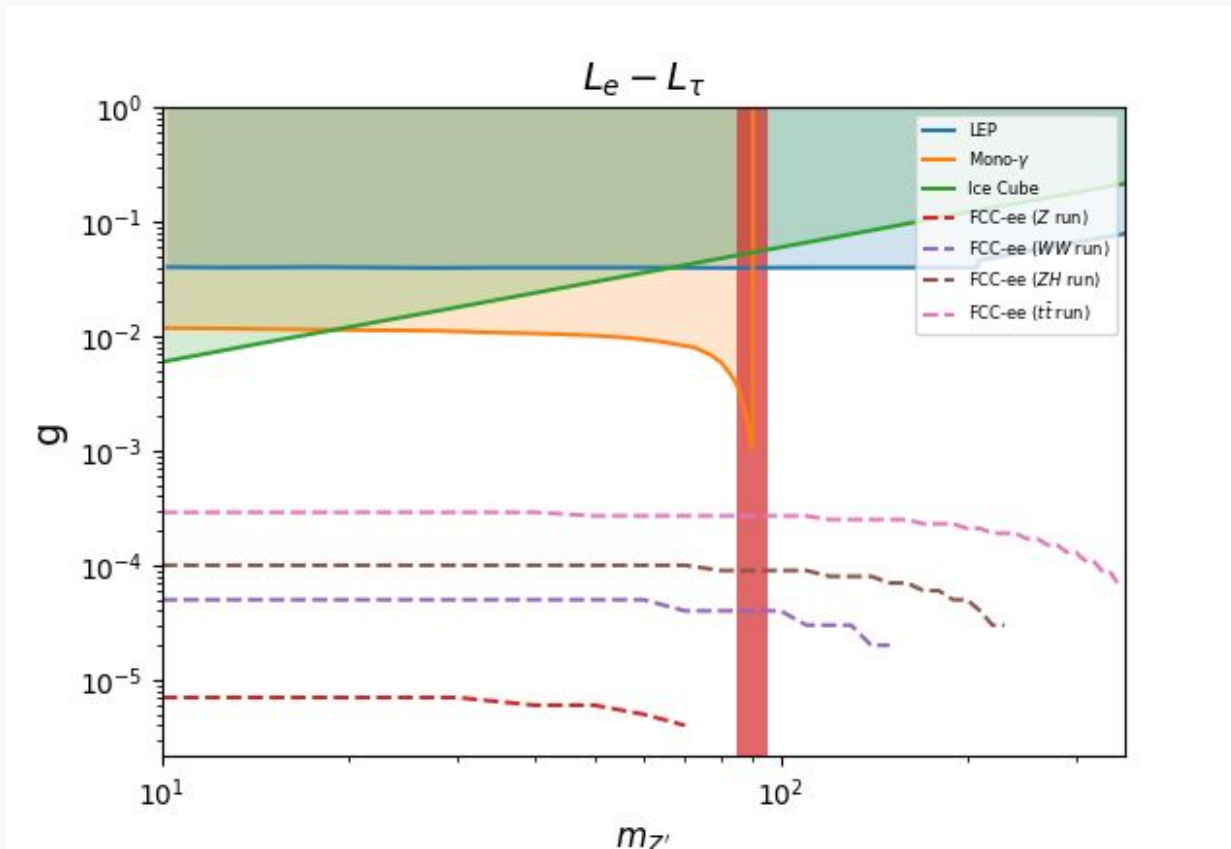
FCC-ee sensitivity

- $e^+ e^- \rightarrow Z' + \text{gamma}$
- Naive sensitivities derived using 10 signal events, background free





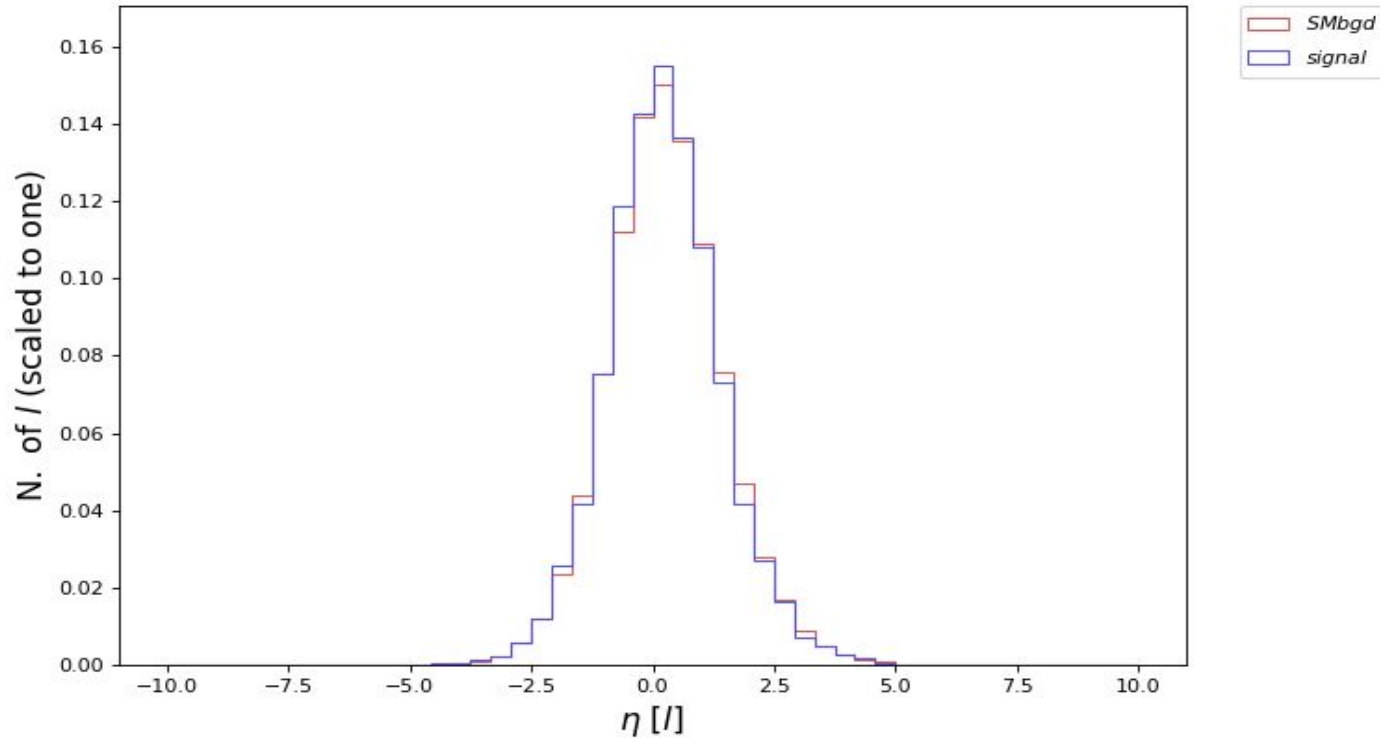
(naively preliminary) FCC-ee sensitivity for four different runs. The lines correspond to 10 signal events. Shaded region around Z mass suffers from high bg and interference effects



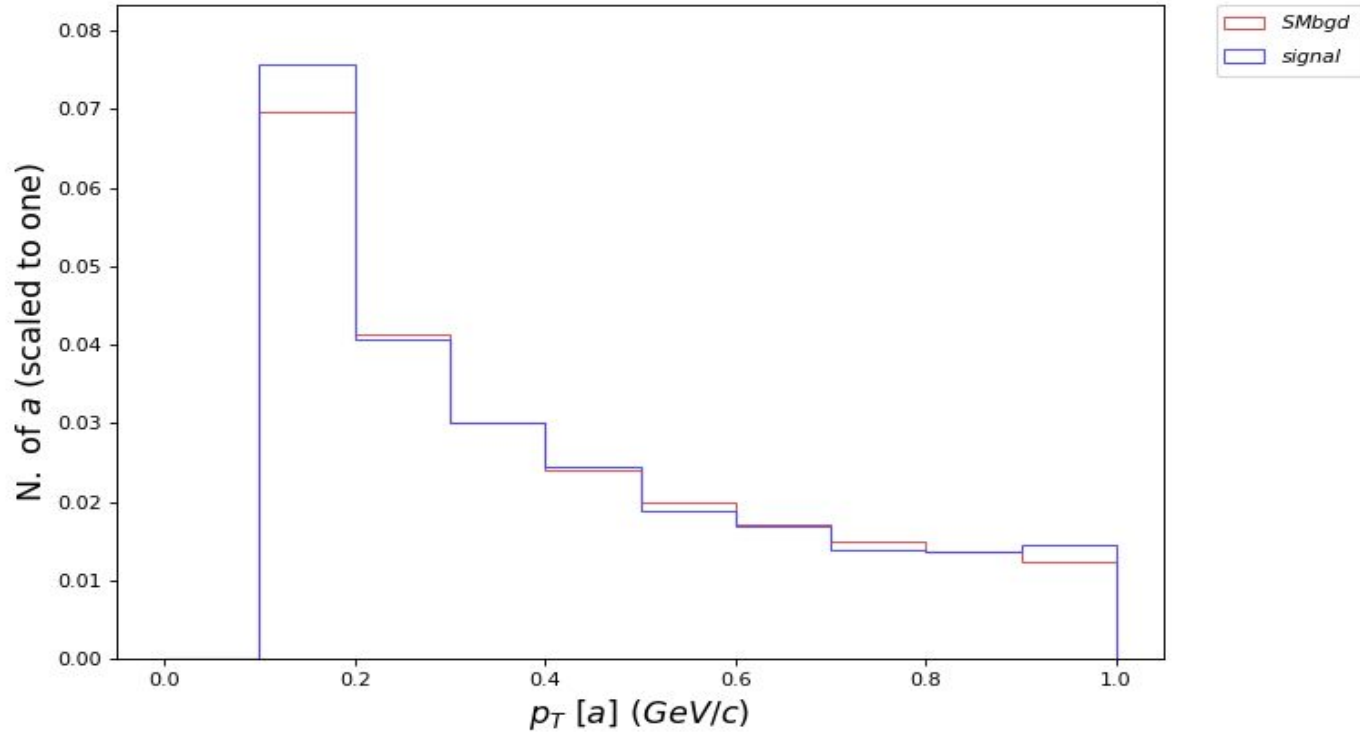
(naively preliminary) FCC-ee sensitivity for four different runs. The lines correspond to 10 signal events. Shaded region around Z mass suffers from high bg and interference effects

To include SM background:

- Focus on invariant mass window $|m-m(Z')| < 0.1m(Z')$
- Cuts taken from DELPHES idea card:
 - $l = e, \mu$: $p_T > 0.5$ GeV, $|\eta| \leq 2.56$, $\Delta R(l, X) > 0.5$, $\epsilon_e = 0.99$
 - γ : $E > 2$ GeV, $p_T > 0.5$, $|\eta| < 3.0$, $\Delta R(\gamma, X) > 0.5$, $\epsilon_\gamma = 0.99$
 - τ : $p_T > 1$ GeV, $|\eta| \lesssim 3.0$, $\Delta R(\tau, X) > 0.5$, $\epsilon_e = 0.85$.

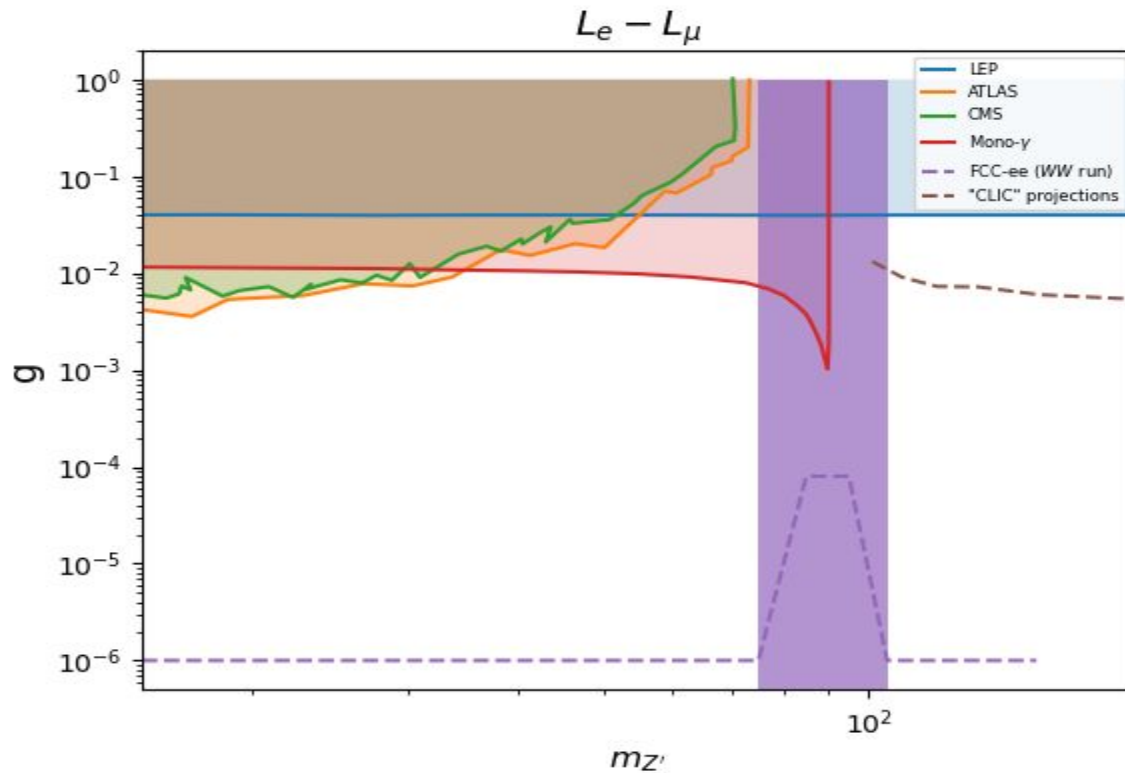


Distribution of lepton pseudorapidity. Extending the forward coverage of FCC-ee will not lead to any significant gains for these models

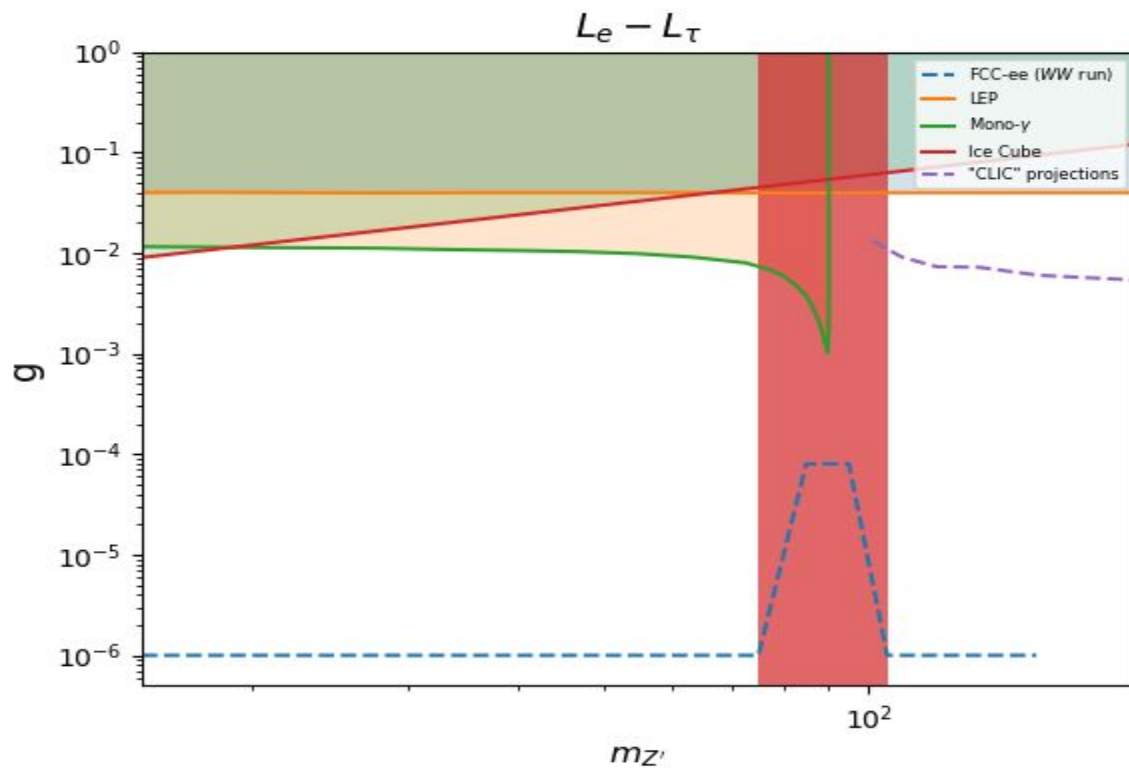


Lowering photon p_T threshold would help us greatly!

Sensitivity plots (preliminary)



Sensitivity plots (preliminary)



Conclusions

- FCC can probe a LOT of existing parameter space for leptophilic Z' models
- Some detector optimization could lead to even better results

What's next?

- Full exploration of FCC-ee capabilities, add showering and detector effects (DELPHES)
- Portal to dark sector? Can it lead to dark showers and long-lived final states (explored for Belle-II, see Kahlhoefer et al (2203.08824))

STAY TUNED!

Thank you!



Backup slides



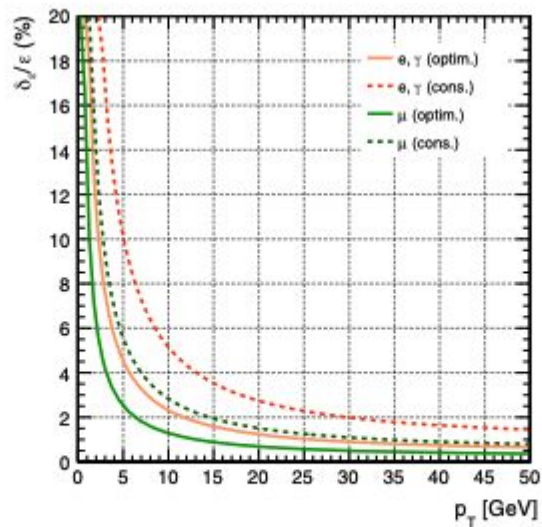


Fig. 4.4 The uncertainty on the reconstruction efficiency of electrons, photons and muons as a function of transverse momentum. An optimistic (solid) and a conservative (dashed) scenario are considered

Existing searches

- LEP
- ATLAS and CMS
- TRIDENT
- g-2
- IceCube