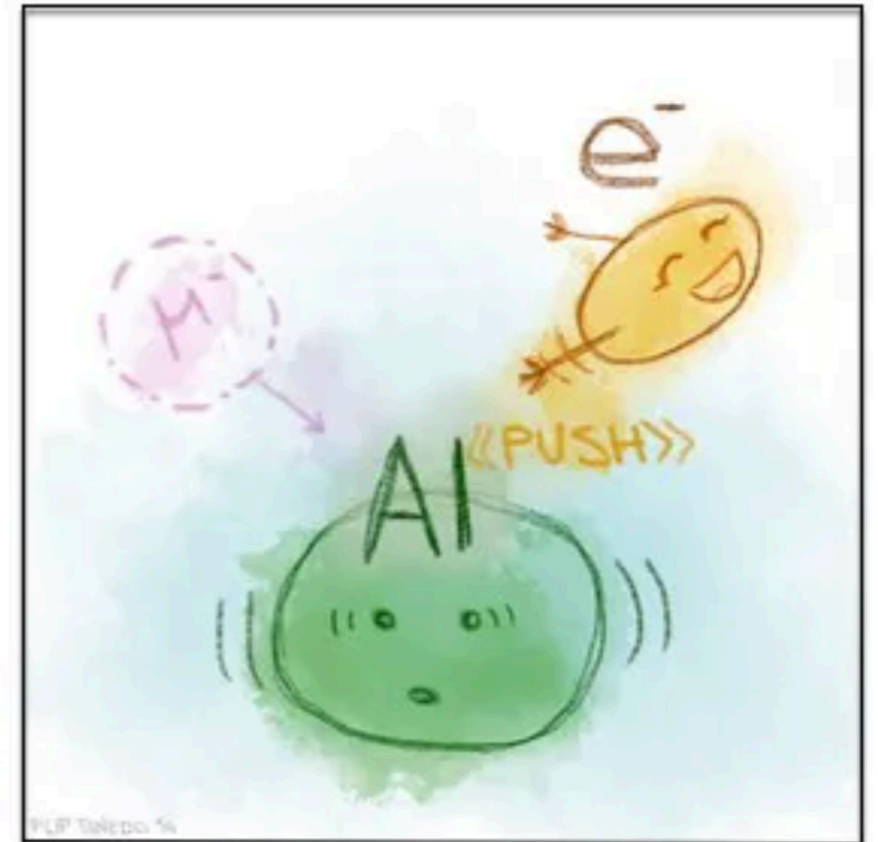


# CLFV and Neutrinos

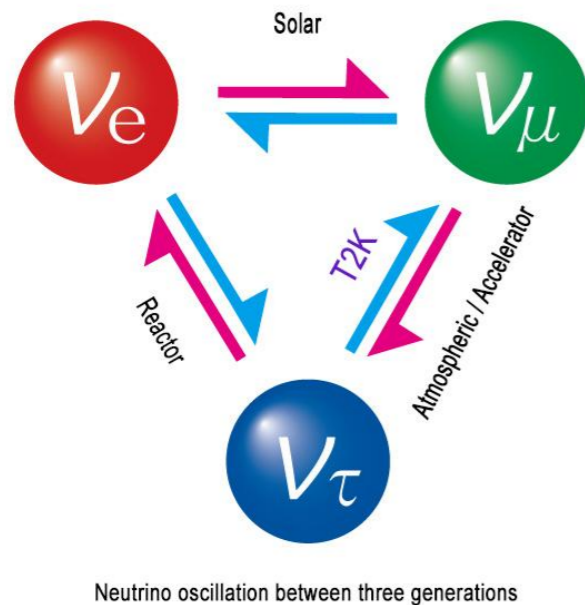
Innes Bigaran (Northwestern and Fermilab)

Ryan Plestid (Caltech)

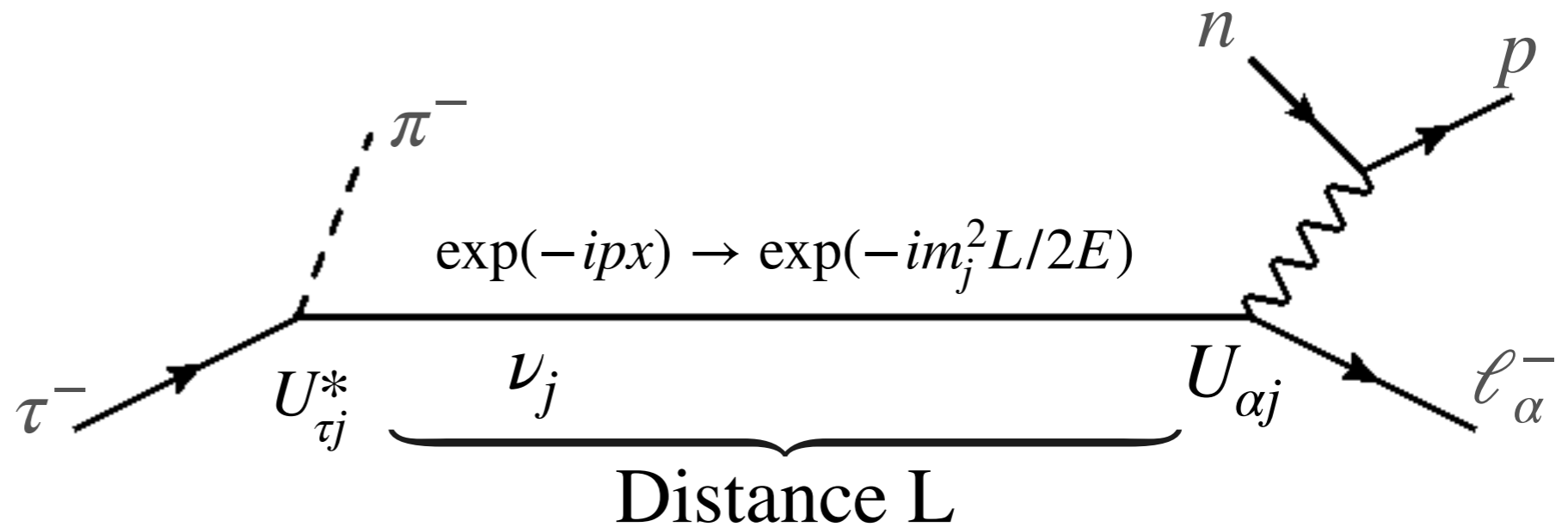
Anil Thapa (Virginia U)



# Neutrino Physics | Motivations



$$|\nu_\alpha\rangle = \sum_{i=e,\mu,\tau} U_{i\alpha} |\nu_i\rangle \implies M_\nu \neq 0$$

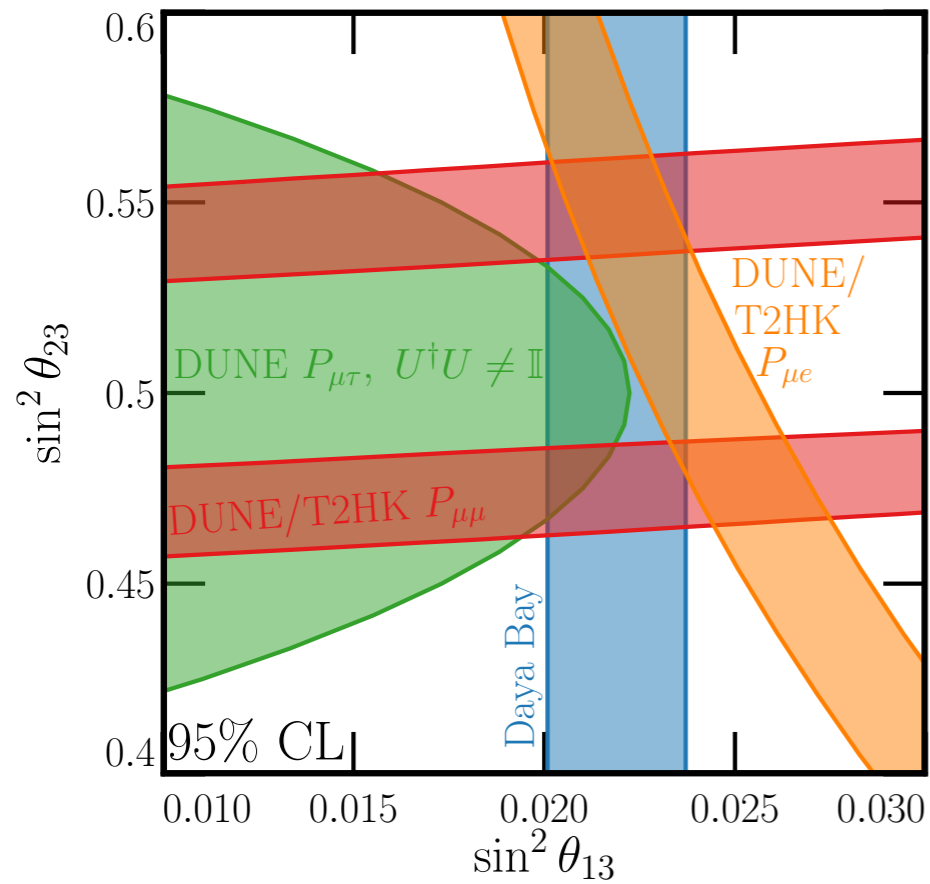


$\nu_\alpha \leftrightarrow \nu_\beta$  prove that SM global symmetry

$$U(1)_{L_e} \times U(1)_{L_\mu} \times U(1)_{L_\tau} \Rightarrow U(1)_{L_\mu - L_\tau} \times U(1)_{L_\mu + L_\tau - 2L_e} \text{ is broken!}$$

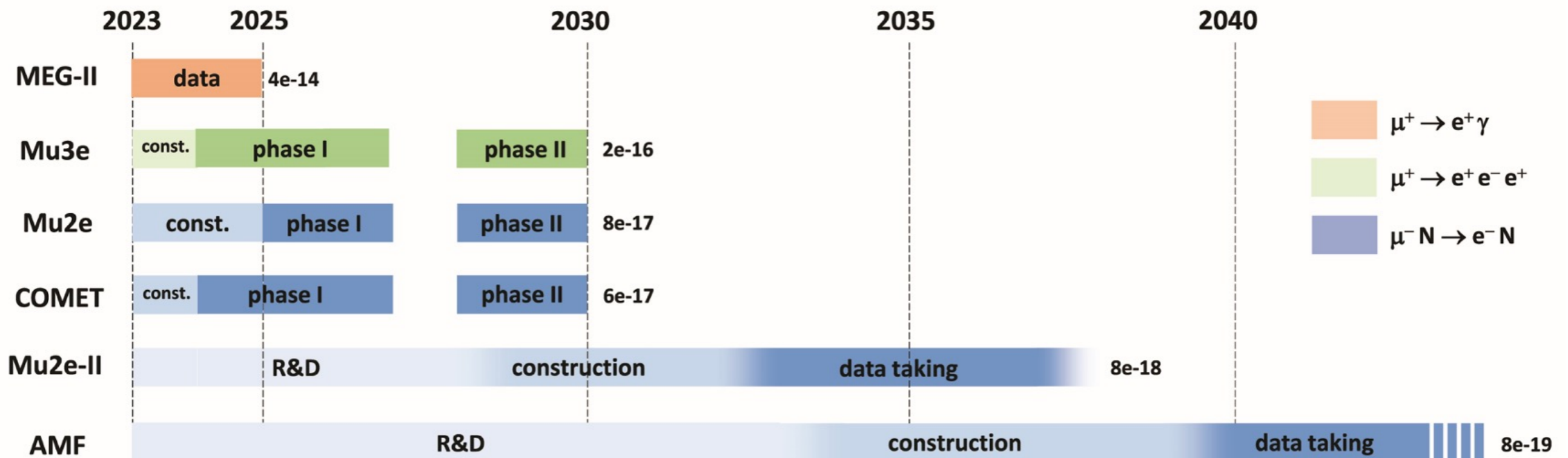
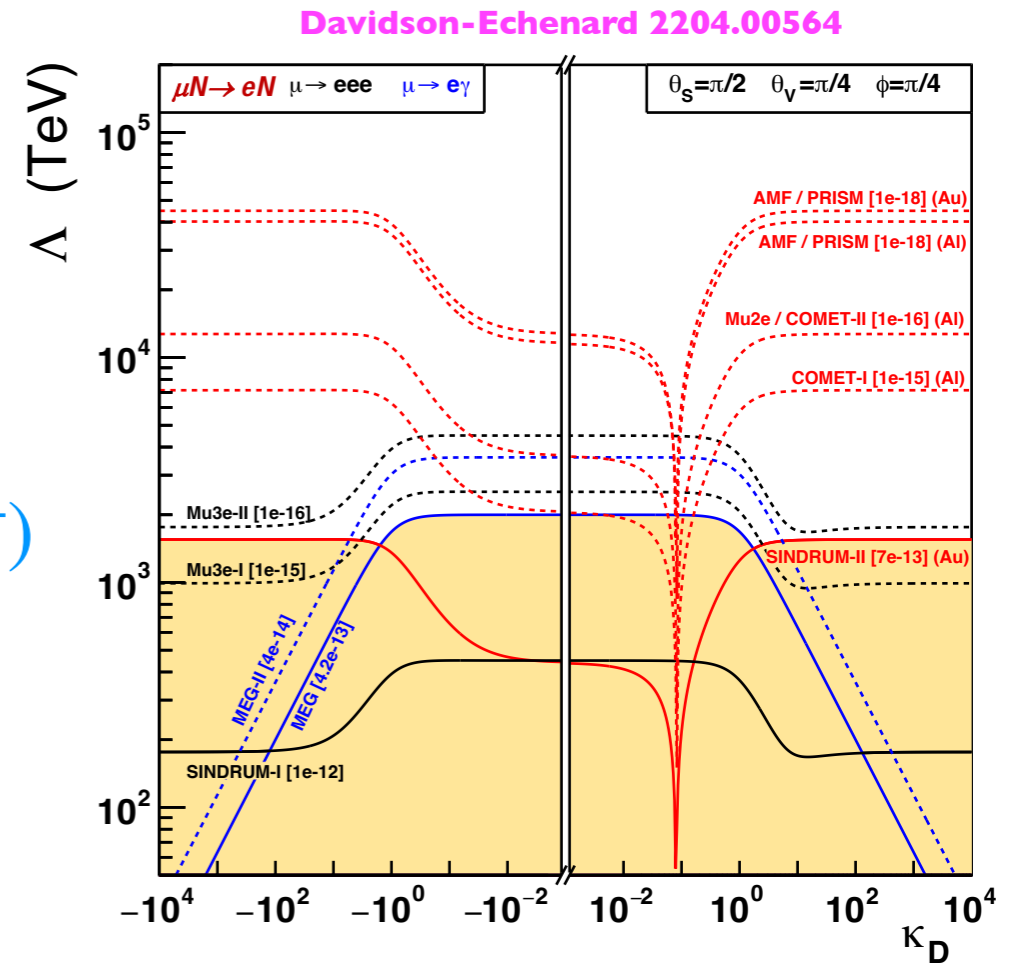
Lepton Flavor is definitely violated, so where is it?

# Nonzero neutrino masses $\Rightarrow$ New Particles

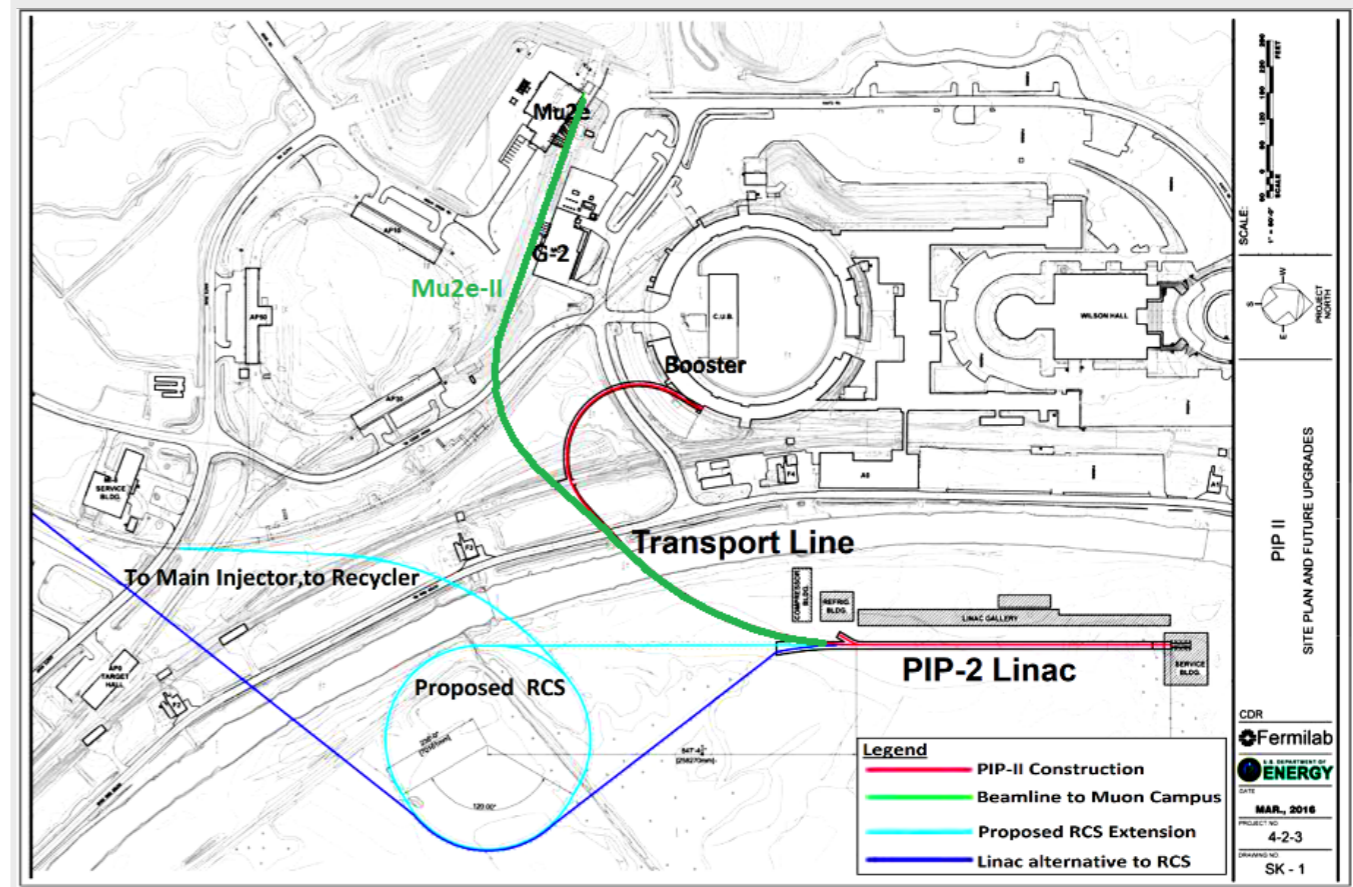


- Ultimately want to test **unitarity in lepton sector**
- CLFV can prove masses  $\mathcal{O}(10^3 - 10^4)$  **TeV. Strongest constraints** on many models.

See talk by Andre and Vincenzo



- Mu2e will improve the current limit on conversion rate  $R_{\mu e}$  by **four orders** of magnitude.
- Mu2e-II will improve  $R_{\mu e}$  by  **$\times 10$  beyond Mu2e limits.**



See talk by Yuri and Eric

## Muonium Oscillations

- Double CLFV.
- Limit set by MACS at PSI:  $P(M\bar{M}) \leq 8.3 \times 10^{-11}$  (90% C.L.)

$$\mu^+ e^- \leftrightarrow \mu^- e^+$$

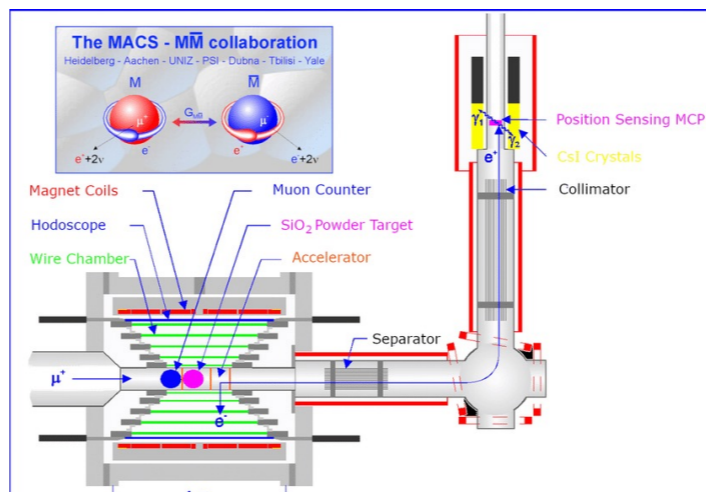
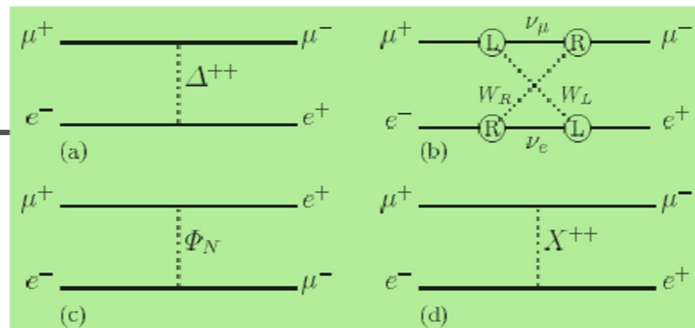
- Lots of new physics: Leptoquarks, doubly charged Higgs, Heavy Majorana neutrinos,...

**Signal =  $\mu^-$  coinciding with an  $e^+$ ;**  
**Backgrounds =  $e^+ e^-$  scattering and rare  $\mu^+ \rightarrow e^+ e^+ e^- \nu_e \bar{\nu}_\mu$ .**

### At AMF:

- Both backgrounds can be suppressed with a pulsed beam and waiting out the muon lifetime;
- can make up the muon flux at a hotter beam, which did not exist at the time of MACS;
- An improvement of x100 should be achievable at AMF.

Design of experiment still needs to be finalized!

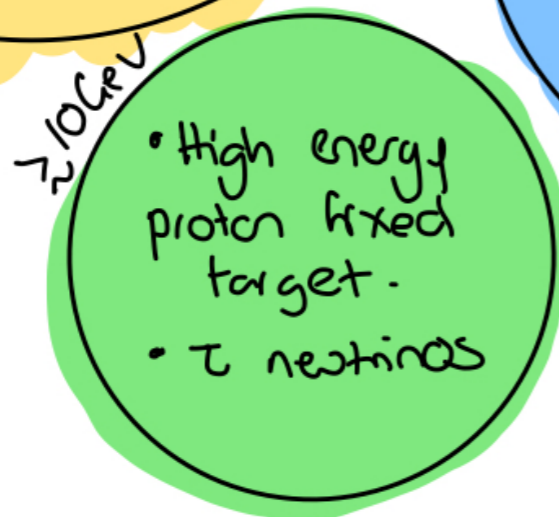


See talk by Sophie and Daniel

“AMF would enable any science needing high intensity muon beams; more than just CLFV experiments”

# Connections to FNAL - ACE

What can we do with different proton energy targets?



## Discussion session

1. CLFV experiments
2. Neutrino experiments
3. Complementarity of 1&2
4. Open floor

# Result of Discussion

- It would be useful to have neutrino-mass motivated targets for CLFV experiments. Are there interesting targets to shoot for? Simplified models?
- Muon deep inelastic scattering on polarized targets (extension of Spin-Quest), and potential opportunities for neutrino-DIS experiment.
- Viability of Fermilab as a leader in muon decays (i.e.  $\mu \rightarrow e\gamma$  and  $\mu \rightarrow 3e$ ) as well as muon conversion.
- Could there be room for a neutrino factory-like concept at an advanced muon facility (i.e. take advantage of muon storage facility)?