VECTORLIKE LEPTONS AT THE LARGE HADRON COLLIDER

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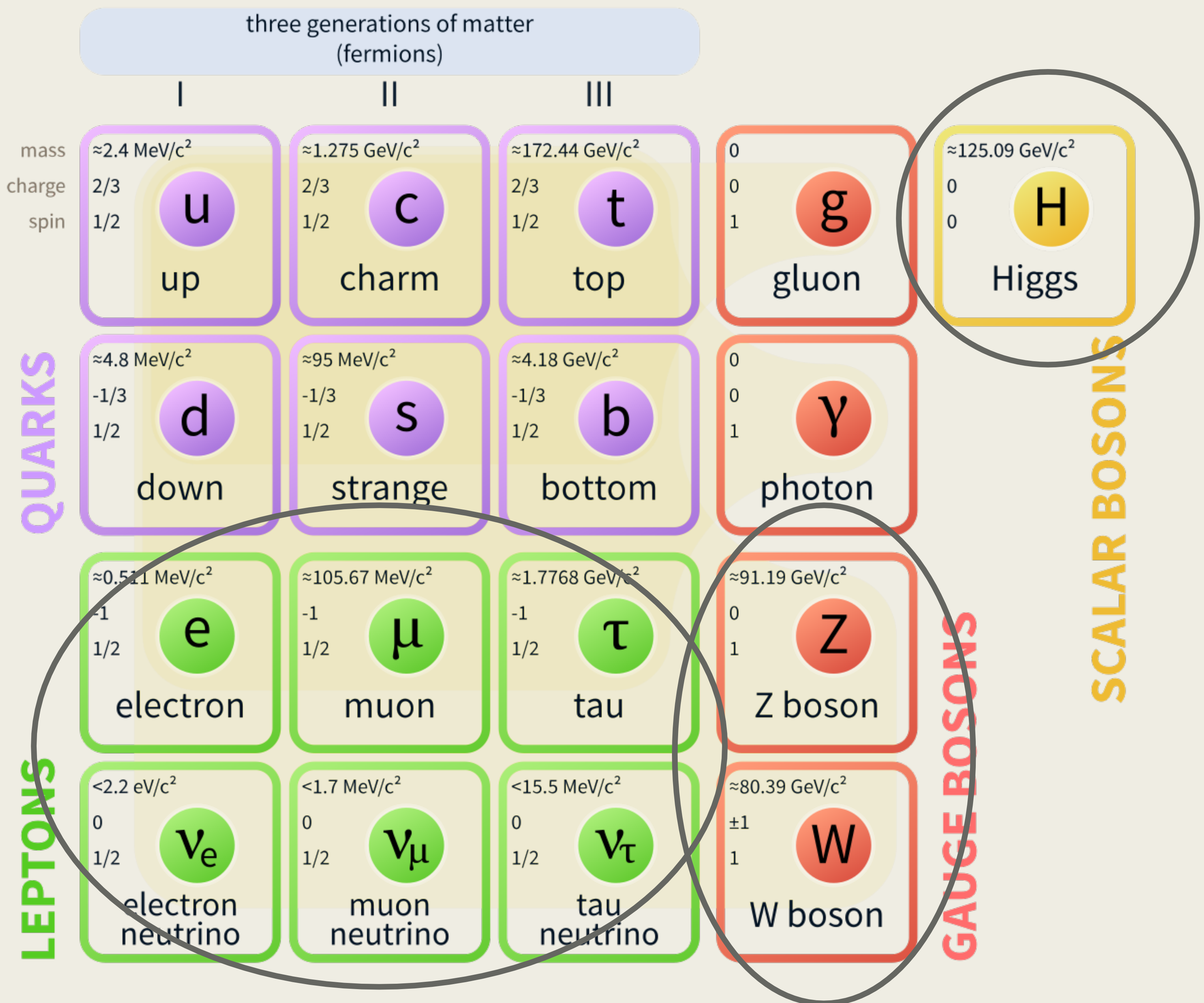
Standard Model of Elementary Particles

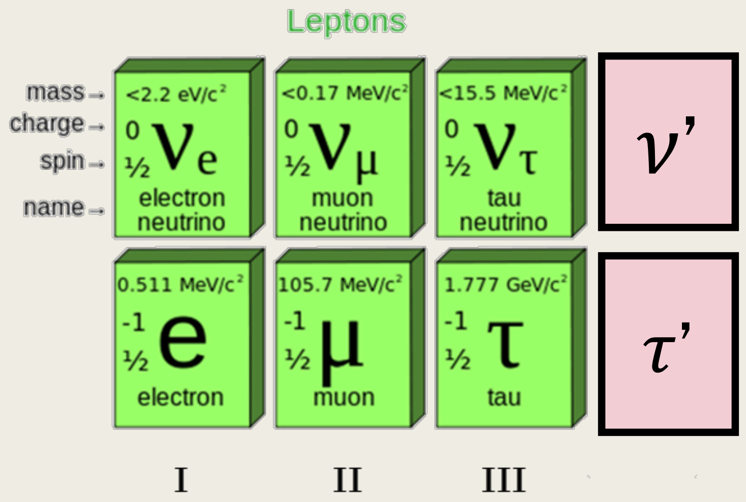


- Largest collider in the world functioning at the highest energy
- ~ 40 Million collisions/s, recording only ~1000 collisions/s
- > 10^{10} events/year

$\sqrt{s} = 13\ TeV$

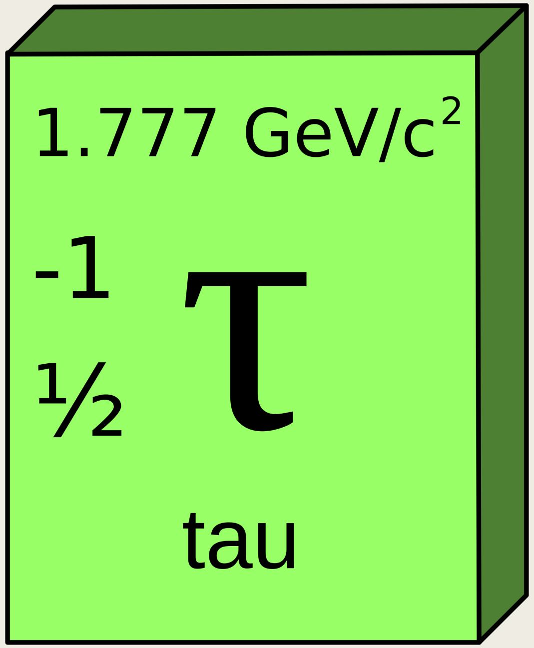
What is a vector-like lepton?

- We don't know the mass
- Looking for it's existence
- Based on measurements m > 100 GeV
- Heavy (theoretically $\simeq$ mass of iron atom)
- Written as τ', ν'



Theory

- τ'/ν' couples to τ
  - *Least well measured*
  - *Most room for extra-SM behavior*
- Several anomalies in our comparison to the standard model, and vectorlike leptons may help explain this.



Why?

- Fourth generation lepton
  - *Could redefine boundary of lepton flavor violation*
  - *May explain muon g-2 anomaly*
  - *Give insight to large dimension behavior*
- String theory
  - *Predicts vectorlike particles*
- We're looking for a discrepancy from the Standard Model

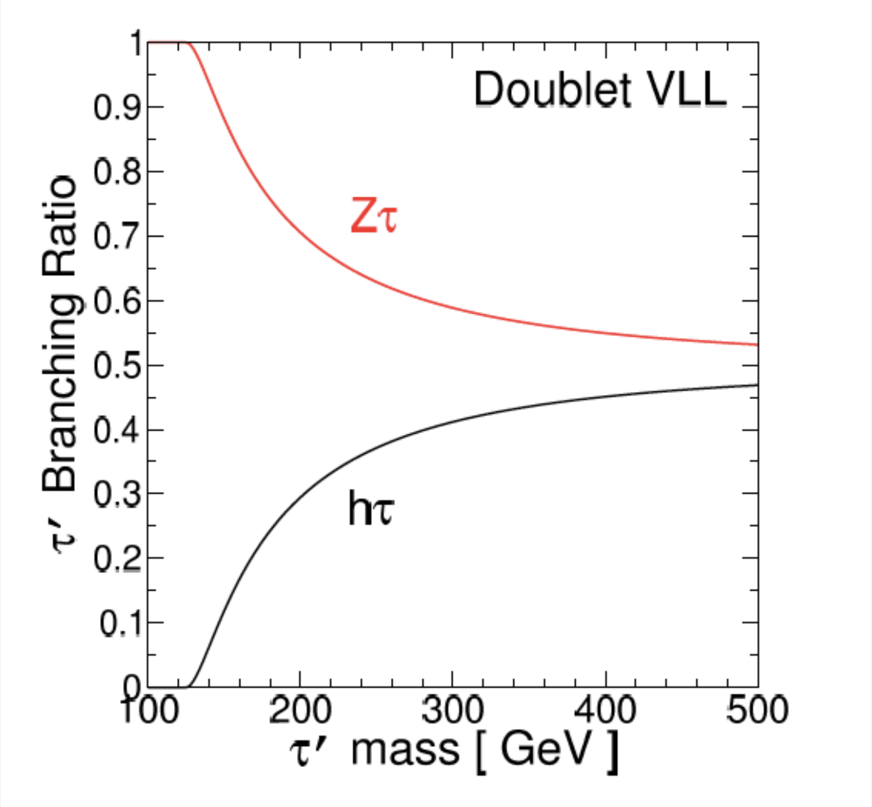
Finding a Region of Interest

- Understand theoretical model
- Create simulations for both theoretical and standard models
- Look at regions that high expected signal and low background
- Signal vs. Background

Decay paths of Tau prime

- Particle discovery
  - Look at theoretical behavior of particle
  - Look for rare signatures
    - Decays to tau/boson pairs
  - Decays with more than two leptons are extremely rare but common in theoretical decays of τ'
- τ' can decay into
  - $Z\tau$
  - $H\tau$
- ν' can decay into
  - $W\tau$
- Initial decays:

(PP $\rightarrow$ $\tau'\tau'$ $\rightarrow$ $Z\tau Z\tau$)
(PP $\rightarrow$ $\tau'\tau'$ $\rightarrow$ $Z\tau H\tau$)
(PP $\rightarrow$ $\tau'\tau'$ $\rightarrow$ $H\tau H\tau$)
(PP $\rightarrow$ $\tau'\nu'$ $\rightarrow$ $Z\tau W\tau$)
(PP $\rightarrow$ $\tau'\nu'$ $\rightarrow$ $H\tau W\tau$)
(PP $\rightarrow$ $\nu'\nu'$ $\rightarrow$ $W\tau W\tau$)



Regions

- How are we going to search for these particles?
  - *W decays to leptons*
  - *Z decays to two leptons*
  - *H decays to WW then to multiple leptons*
- Expect large amounts of leptons
- Multiple lepton events are rare in the standard model
- Searching for events with a large amount of leptons