τ Leptons: A Gateway to New Physics

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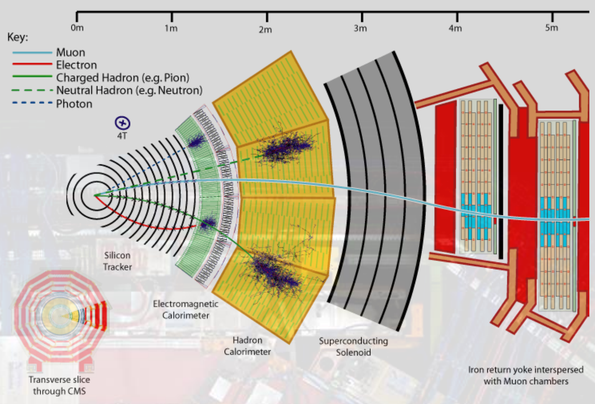
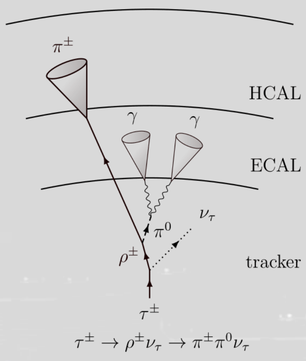
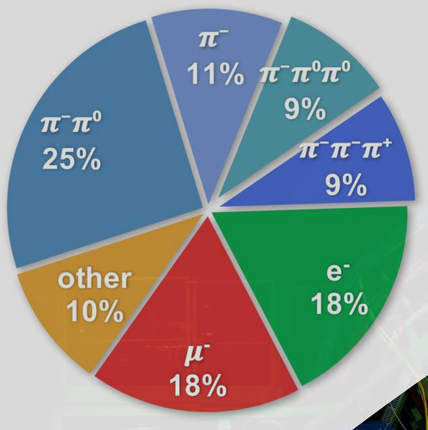
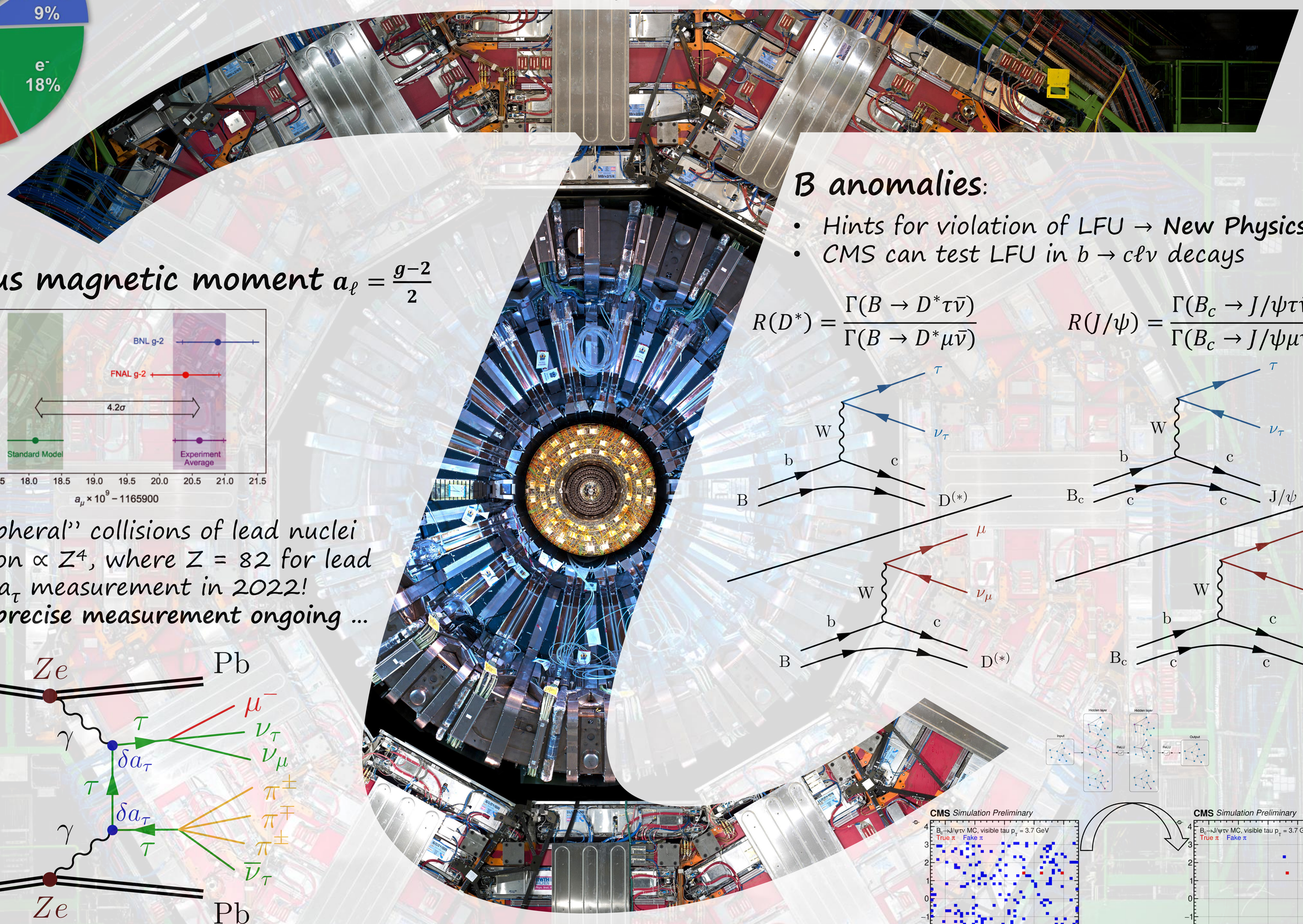
* Bachelor and Master research projects

- Third and heaviest generation of leptons
- Mostly decays to different numbers of pions
- Pathway to examine Lepton Flavor Universality (LFU)
- **New Physics** → Stronger couplings to higher generations

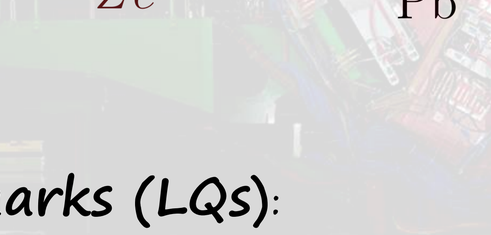




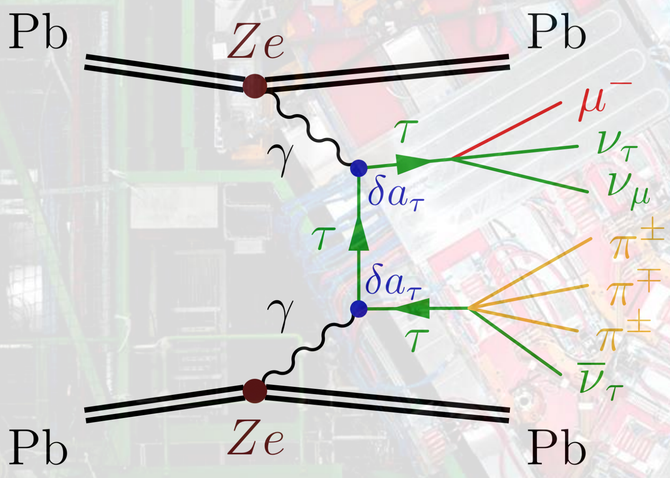




Anomalous magnetic moment $a_\ell = \frac{g-2}{2}$



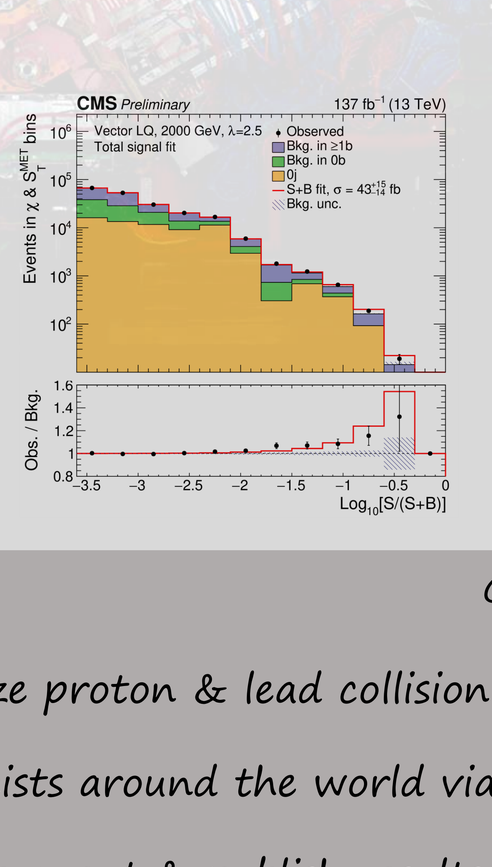
- "Ultraperipheral" collisions of lead nuclei
- Cross section ∝ Z^4, where Z = 82 for lead
- First CMS a_τ measurement in 2022!
  - **A more precise measurement ongoing …**

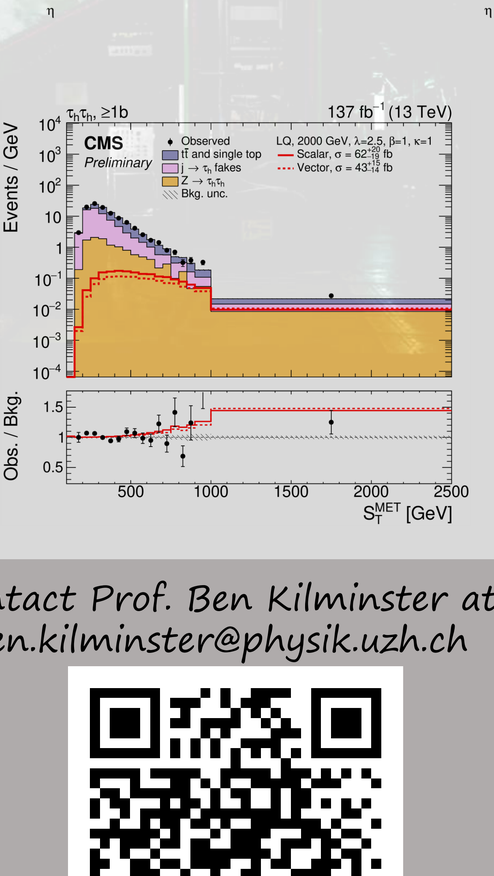


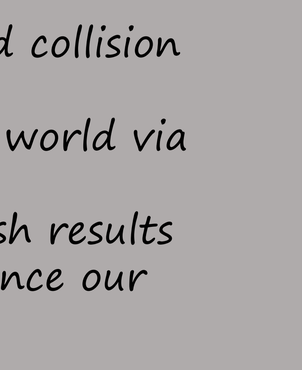
B anomalies:

- Hints for violation of LFU → **New Physics?**
- CMS can test LFU in $b \to c\ell\nu$ decays

$$R(D^*) = \frac{\Gamma(B \to D^* \tau \bar{\nu})}{\Gamma(B \to D^* \mu \bar{\nu})} \qquad R(J/\psi) = \frac{\Gamma(B_c \to J/\psi \tau \bar{\nu})}{\Gamma(B_c \to J/\psi \mu \bar{\nu})}$$

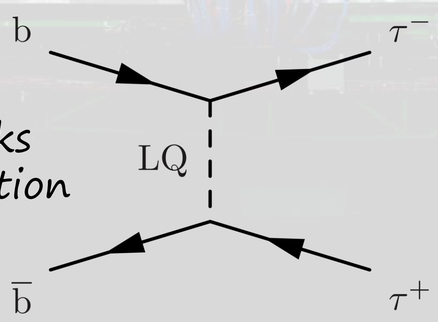






Leptoquarks (LQs):

- Hypothetical particles
- Interacting with quarks & leptons
- Stronger Coupling to massive leptons and quarks
- Can explain the B anomalies through LFU violation
- May interact with **dark matter**



Interested?

Contribute, and acquire new skills & experiences:

- Study the Standard Model of Particle Physics, and New Physics models
- Programming in python, C++, ROOT, …
- Advanced analysis tools like multivariate analysis techniques using deep learning, …

- Simulate and analyze proton & lead collision data
- Interact with physicists around the world via CERN
- Discuss, present, document & publish results
- Help to find New Physics, and advance our understanding of the Universe

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