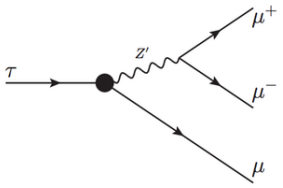


Flavours of Physics: Finding τ → μμμ

Identify a rare decay phenomenon

$15,000 · 673 teams · 2 years ago

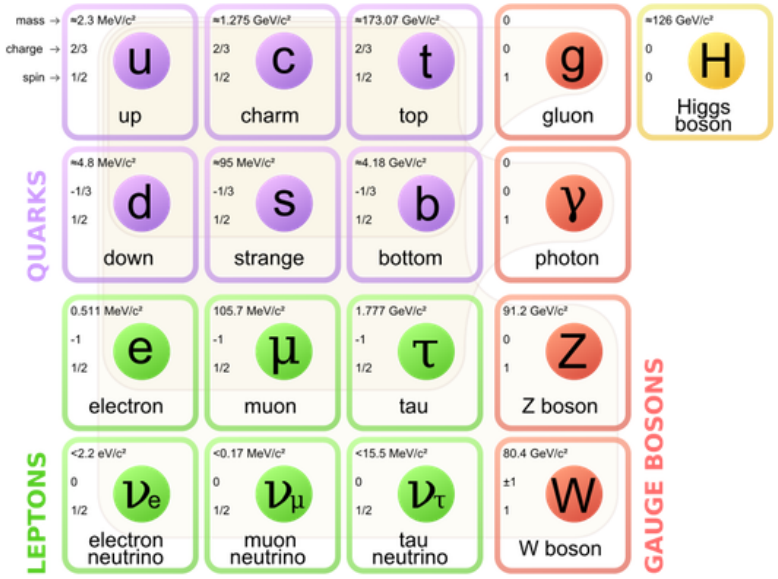
Overview

Like last year's Higgs Boson Machine Learning Challenge, this competition deals with the physics at the Large Hadron Collider (LHC). However, the subject of last year's challenge, the Higgs Boson, was already known to exist. The aim of this year's challenge is to find a phenomenon that is not already known to exist – charged lepton flavour violation – thereby helping to establish "new physics".

Flavours of Physics 101

The laws of nature ensure that some physical quantities, such as energy or momentum, are conserved. From Noether's theorem, we know that each conservation law is associated with a fundamental symmetry. For example, conservation of energy is due to the time-invariance (the outcome of an experiment would be the same today or tomorrow) of physical systems. The fact that physical systems behave the same, regardless of where they are located or how they are oriented, gives rise to the conservation of linear and angular momentum.

Symmetries are also crucial to the structure of the Standard Model of particle physics, our present theory of interactions at microscopic scales. Some are built into the model, while others appear accidentally from it. In the Standard Model, lepton flavour, the number of electrons and electron-neutrinos, muons and muon-neutrinos, and tau and tau-neutrinos, is one such conserved quantity.



The Standard Model of elementary particles

Interestingly, in many proposed extensions to the Standard Model, this symmetry doesn't exist, implying decays that do not conserve lepton flavour are possible. One decay searched for at the LHC is $\tau^- \rightarrow \mu^+\mu^-\mu^-$ (or τ → 3μ). Observation of this decay would be a clear indication of the violation of lepton flavour and a sign of long-sought new physics.

Competition Design

You will be working with real data from the LHCb experiment at the LHC, mixed with simulated datasets of the decay. The metric used in this challenge includes checks that physicists do in their analysis to make sure the results are unbiased. These checks have been built into the competition design to help ensure that the results will be useful for physicists in future studies.

To get started, review the Data Page, and be sure to download the Starter Kit. The Starter Kit will help you to get used to the unique submission procedure for this competition.

Competition Video Tutorial

You've got lots of questions. Researchers at CERN & LCHb have the answers.

- What is the goal of this competition? (1:56)
- Why is finding τ → μμμ exciting? (2:18)
- What are flavours? (4:10)
- Why use machine learning to find τ → μμμ? (4:57)
- How did you decide on the size of the dataset? (5:31)
- Why is weighted AUC the evaluation metric? (6:09)
- Why use Ds → φπ data for the Agreement Test? (7:53)
- Why do we need a Correlation Check? (8:44)
- How will the competition results impact what you do? (11:38)
- How will the competition results be used at CERN? (12:17)

Resources

Flavour of Physics, Research Documentation

Roel Aaij et al., Search for the lepton flavour violating decay τ → μμμ, 2015, JHEP, 1502:121, 2015

New approaches for boosting to uniformity

Acknowledgements

This competition is brought to you by:

CERN LHCb SCHOOL OF DATA ANALYSIS

Yandex Data Factory

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University of Zurich[UZH]

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Rules Acceptance

Deadline

673 Teams
706 Competitors

Points **This competition awarded standard ranking points**
Tiers **This competition counted towards tiers**

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