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Seminar in Particle Physics and Astrophysical Sciences PAP301

Probing for new physics with all-hadronic vector boson scattering

In the framework of the Standard Model of particle physics, bosons are particles with integer spin; particles with spin equal to one are termed vector bosons. Vector boson scattering (VBS) is the process by which W or Z bosons, mediators of the weak force, interact with each other to produce either an all-leptonic, semi-leptonic, or all-hadronic final state. We concentrate our search for new physics in the all-hadronic channel due to its sensitivity to beyond-Standard-Model (BSM) processes; BSM effects become noticeable at the teraelectronvolt mass-scale, for which the channel with the highest final state mass is required.

The data analysis component of the thesis is part of the ForVVard project with the Helsinki Institute of Physics. It utilizes data taken during Run 2 of the Large Hadron Collider (LHC) by the Compact Muon Solenoid (CMS) detector. We have so far analyzed generator-level data of electroweak (EWK), quantum chromodynamic (QCD), and combined (EWKQCD) samples. We have constructed histograms from simulated events; these include the invariant mass of each event as well as transverse momentum, mass, pseudorapidity, and azimuthal angle of each relevant particle. Results have been normalized so that the shapes of the distributions can be compared regardless of relative sample size.

Although all-hadronic VBS is promising due to its ability to provide insight into the higher-mass end of the phase space, where BSM processes are expected to manifest, the major challenge is the resulting small cross-section; the rarity of such events requires a greatly increased sample size, for which we use Monte Carlo bootstrapping to bolster detector results.