Contribution ID: **173**   Type: **talk**

Search for the Decay of the Higgs Boson to Charm Quarks with the ATLAS Experiment

Monday 12 July 2021 14:45 (15 minutes)

The measurements at the Large Hadron Collider(LHC), so far, have established Higgs Yukawa couplings to Fermions are close to the Standard Model(SM) expectation for the 3rd Fermion generation. However, the rather ad hoc assumption of universal Yukawa coupling for other Fermion generations has a little experimental constraint. This is very challenging to probe due to small branching fractions, extensive quantum chromodynamics(QCD) backgrounds, and difficulties in jet flavor identification. A direct search by the ATLAS experiment for the SM Higgs boson decaying to a pair of charm quarks is presented. The dataset delivered by the LHC in pp collisions at $\sqrt{s} = 13$ TeV and recorded by the ATLAS detector corresponds to an integrated luminosity of 139 fb-1. Charm tagging algorithms are optimized to distinguish c-quark jets from both light flavor jets and b-quark jets. The analysis method is validated with the study of diboson (WW, WZ, and ZZ) production, with observed (expected) significances of 2.6(2.2) standard deviations above the background-only hypothesis for the (W/Z)Z($\rightarrow$cc⁻) process and 3.8(4.6) standard deviations for the (W/Z)W($\rightarrow$cq) process. The (W/Z)H($\rightarrow$cc⁻) search yields an observed (expected) limit of 26(31) times the predicted cross-section times branching fraction for a Higgs boson with a mass of 125 GeV, corresponding to an observed (expected) constraint on the charm Yukawa coupling modifier |κc|<8.5(12.4), at the 95% confidence level.

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Session Classification: Higgs & Electroweak Physics

Track Classification: Higgs & Electroweak Physics