The Beauty of the Higgs boson

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Abstract
By measuring the properties of the Higgs boson and comparing them to theoretical predictions, physicists can better understand this unique particle and search for deviations from predictions that would point to new physics processes beyond our current understanding of particle physics. The Higgs boson decay to a b-quark pair is the ideal search channel to search for such deviations in the production rate. The ATLAS Collaboration studied the full LHC Run-2 dataset to measure this decay, where the Higgs boson is produced in association with a vector boson (W or Z), at large transverse momenta.

Project Description
The decay of the Higgs boson into pairs of bottom-quarks ($H \to b\bar{b}$) is expected to have a branching ratio of 58%, the largest among all decay modes. This poster presents the highlights of the measurement of a high transverse momentum $H \to b\bar{b}$ in association with a leptonically decaying W or Z boson. When the Higgs boson is produced at very large transverse momentum, exceeding twice the Higgs-boson mass of 125 GeV, the H→bb system is "boosted" [1].
The two b-quarks tend to be produced close together, merging into one sprays of highly collimated and energetic particles, called "jet" (as shown Figure 1). This measurement allowed physicists to identify boosted H→bb decays, reconstruct the mass of the Higgs boson, and identify an excess over the background processes, as shown in Figure 2.

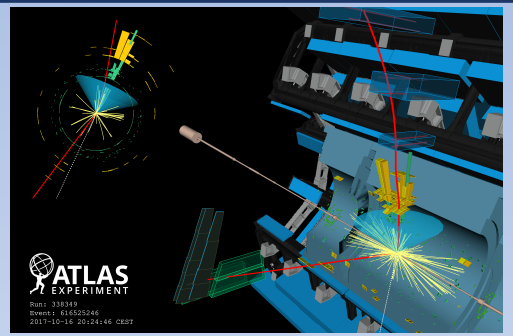

Figure 1: A very boosted $H \to b\bar{b}$ event display from the ATLAS detector where particles originating from the two b-quarks (green and yellow energy deposits in the calorimeters) have been merged into a single jet (blue cone).

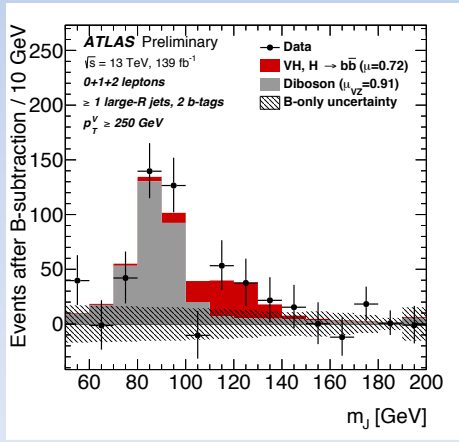

Figure 2: A comparison of the excess of collision data (black points) over the background processes (subtracted from the data). Shown are the reconstructed mass from the H→bb decays (red) and the well-understood diboson (WZ or ZZ) Z→bb decay (grey) used to validate the result.

The results shown in Figure 2 correspond to the most precise measurement currently available in the high transverse momentum regime for this process. The $H \to b\bar{b}$ decay in association with a W or a Z boson observed (expected) significance is 2.1σ (2.7σ). The boosted technique allowed ATLAS to explore the particularly interesting large transverse momentum events with improved efficiency. This represents an important advancement in the search for new physics.

[1] ATLAS Collaboration, ATLAS-CONF-2020-007