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The case of Higgs boson production in $H \to ZZ^*$ decay

Introduction to the Particle Physics Data Analysis

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Outline

Physics motivation

The physics motivation for the measurement:

- a good test for the SM,
- a measurement of inclusive and differential fiducial cross sections,
- tests of the spin and parity of the Higgs boson,
- test of perturbative QCD calculations.

The Feynman diagram

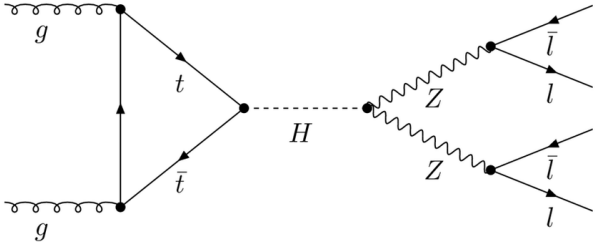

Figure: Feynman diagram for $H \to ZZ^* \to 4\ell$ decay [3].

Event selection

The final event-selection criteria for ZZ^* production:

- single-electron or single-muon trigger satisfied,
- exactly four leptons (electrons or muons) with $p_T > 25, 15, 10, 7\,GeV$, respectively,
- Higgs-boson candidates are formed by selecting two *SFOS* lepton pairs,
- the leading pair is defined as the *SFOS* [1] pair with the mass $m_{\ell\ell,1}$ closest to the Z boson mass m_Z, and the subleading pair is defined as the SFOS pair with the mass $m_{\ell\ell,1}$ second closest to m_Z. [1]

[1] *SFOS* - Same Flavour, Opposite Charge

Cutflow Histogram

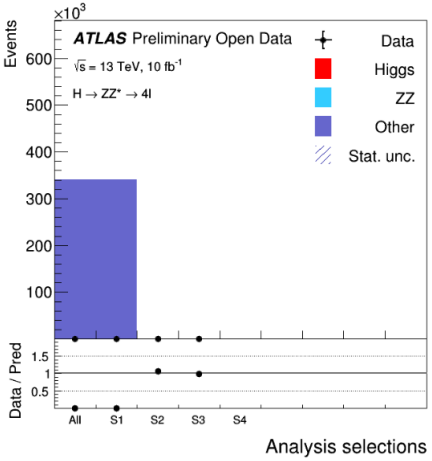

Figure: The cutflow histogram: $S1$ - single-electron or single-muon trigger satisfied, $S2$ - four leptons with $p_T > 25, 15, 10, 7 GeV$, $S3$ - two SFOS lepton pairs.

Expected number of events

Expected number of events equals:

$$N^{H\to ZZ^*\to 4\ell} = \sigma^{H\to ZZ^*\to 4\ell}_{incl} \cdot L_{int}, \tag{1}$$

where:

$$\sigma^{H\to ZZ^*\to 4\ell}_{incl} = 3{,}62\ fb^{-1},$$
$$L_{int} = 10{,}06\ fb^{-1}.$$

$$N^{H\to ZZ^*\to 4\ell} = 3,62\ \mathrm{fb} \cdot 10,06\ \mathrm{fb}^{-1} = 36,42. \tag{2}$$

Number of Leptons

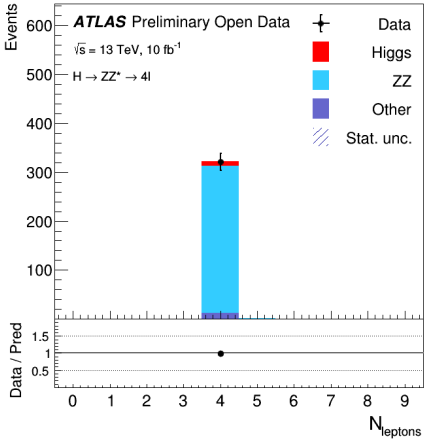

Figure: The histogram with number of leptons.

Bibliography I

The ATLAS collaboration
Review of the 13 TeV ATLAS Open Data release
https://cds.cern.ch/record/2707171

Aaboud, Morad and others
Measurement of inclusive and differential cross sections in the $H \to ZZ^* \to 4\ell$ decay channel in pp collisions at $s = 13\,TeV$ with the ATLAS detector
http://dx.doi.org/10.1007/JHEP10(2017)132

Passon, Oliver
On the interpretation of Feynman diagrams, or, did the LHC experiments observe the Higgs to gamma gamma decay?