

The case of Higgs boson  
production in  $H \rightarrow ZZ^*$  decay  
Introduction to the Particle Physics Data  
Analysis

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# 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

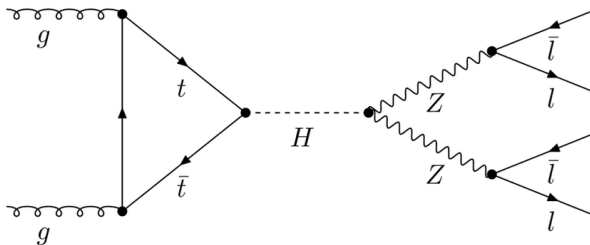


Figure: Feynman diagram for  $H \rightarrow ZZ^* \rightarrow 4\ell$  decay [3].

# Event selection



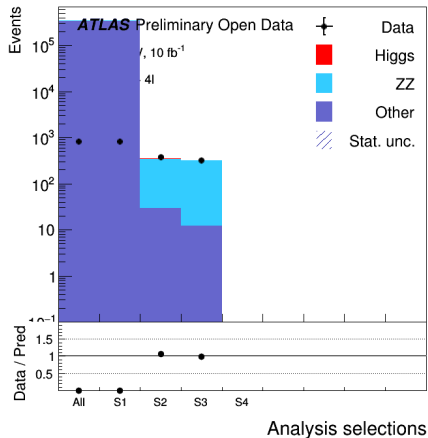
The final event-selection criteria for  $ZZ^*$  production:

- single-electron or single-muon trigger satisfied,
- exactly four leptons (electrons or muons) with  $p_T > 25, 15, 10, 7 \text{ GeV}$ , respectively,
- Higgs-boson candidates are formed by selecting two *SFOS* lepton pairs,
- the leading pair is defined as the *SFOS*<sup>1</sup> 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]

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<sup>1</sup>*SFOS* - Same Flavour, Opposite Charge

# Cutflow Histogram



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

# Expected number of events



Expected number of events equals:

$$N^{H \rightarrow ZZ^* \rightarrow 4\ell} = \sigma_{incl}^{H \rightarrow ZZ^* \rightarrow 4\ell} \cdot L_{int}, \quad (1)$$

where:

$$\sigma_{incl}^{H \rightarrow ZZ^* \rightarrow 4\ell} = 3,62 \text{ fb}^{-1},$$

$$L_{int} = 10,06 \text{ fb}^{-1}.$$

$$N^{H \rightarrow ZZ^* \rightarrow 4\ell} = 3,62 \text{ fb} \cdot 10,06 \text{ fb}^{-1} = 36,42. \quad (2)$$

# Number of Leptons

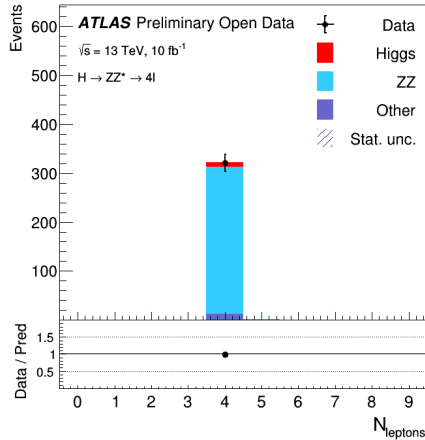


Figure: The histogram with number of leptons.



# 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  $H \rightarrow ZZ^* \rightarrow 4\ell$  decay channel in pp collisions at  $s\sqrt{= 13\text{ TeV}}$  with the ATLAS detector

[http://dx.doi.org/10.1007/JHEP10\(2017\)132](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?