

Exploring the public data of ATLAS

Laboratório de Instrumentação e Física Experimental de Partículas

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1 Introduction

- The Atlas Detector
- The Higgs boson
 - Higgs Production Modes and Decays Channels
- Relevant variables

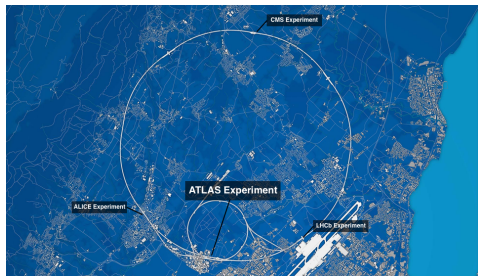
2 Studied Events

- Two-lepton final state: the case of SM Higgs boson production in the $H \rightarrow WW^*$ decay channel
- Four-lepton final state: the case of SM Higgs boson production in the $H \rightarrow ZZ^*$ decay channel
- Two-photon final state: the case of SM Higgs boson production in the $H \rightarrow \gamma\gamma$ decay channel

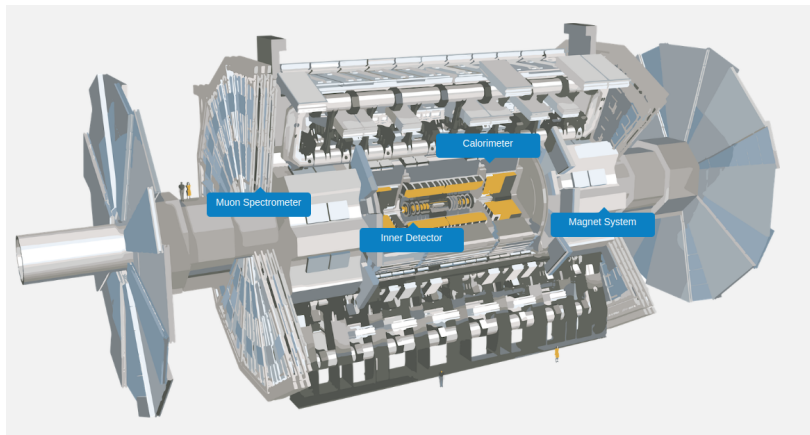
3 Experimental Execution

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The Atlas Detector - LHC



The Atlas Detector

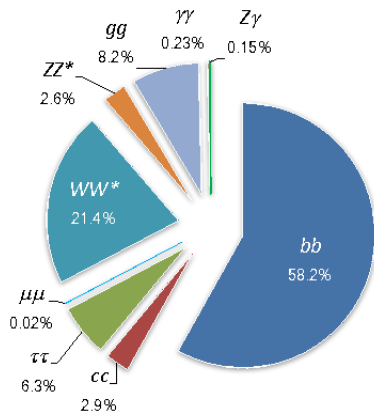
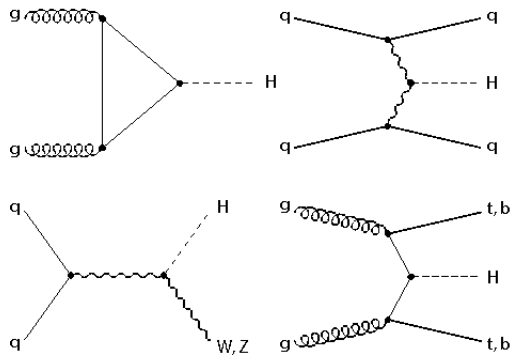


The Higgs boson

The experimental confirmation of the existence of the Higgs Boson was one of the many goals of the study of the collision of particles at ATLAS.

2022 is the 10th anniversary of the Higgs confirmation

Higgs Production Modes and Decays Channels



Relevant variables

- θ : polar angle of the trajectory of a particle;
- $\eta = -\ln(\tan \theta/2)$: pseudorapidity;
- ϕ : angle of the trajectory of the object in the plane transverse to the direction of the proton beams;
- $\Delta R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2}$: separation between reconstructed objects in the detector;
- m_H : total invariant mass;
- $m_{\gamma\gamma}$: diphoton invariant mass;
- p_T : transverse momentum;
- E_T : transverse energy
- E_T^{miss} : missing transverse momentum
- $\Delta\phi(l, E_T^{miss})$: azimuthal angle between the missing transverse momentum and the dilepton system.
- p_T^{\parallel} : transverse momentum of the dilepton system

Two-lepton final state: the case of SM Higgs boson production in the $H \rightarrow WW^*$ decay channel

$$H \rightarrow WW^* \rightarrow e\nu\mu\nu \quad (1)$$

Final event-selection criteria:

- Single-electron or single-muon trigger satisfied;
- Exactly an electron and a muon with opposite signs and $p_T > 22$ and 15 GeV, respectively;
- $E_T^{miss} > 30$ GeV;
- Exactly zero or at most one jet with $p_T > 30$ GeV, and exactly zero b-tagged jets (MV2c10 @ 85% WP) with $p_T > 20$ GeV;
- $\Delta\phi(l, E_T^{miss}) > \frac{\pi}{2}$;
- $p_T^l > 30$ GeV;
- $10\text{GeV} < M_{ll} < 55\text{GeV}$;
- $\Delta\phi(l, l) < 1.8$;

$$H \rightarrow ZZ^* \rightarrow 4l \quad (2)$$

Event-selection criteria:

- 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 (Same Flavour Opposite Sign) lepton pairs;

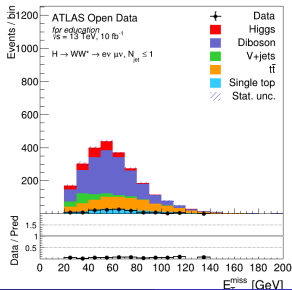
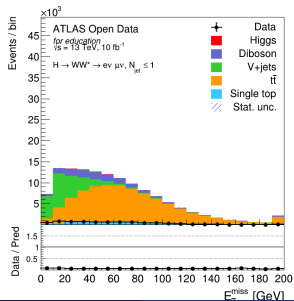
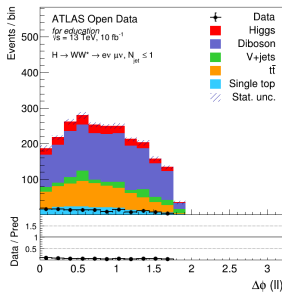
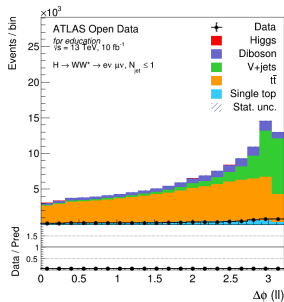
Two-photon final state: the case of SM Higgs boson production in the $H \rightarrow \gamma\gamma$ decay channel

$$H \rightarrow \gamma\gamma \quad (3)$$

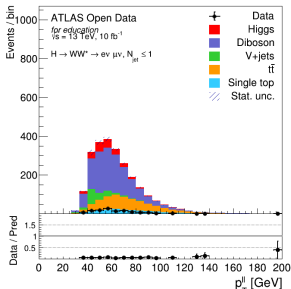
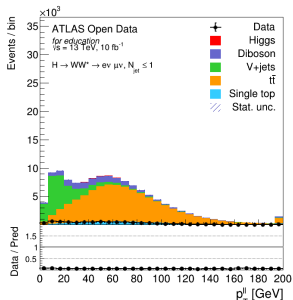
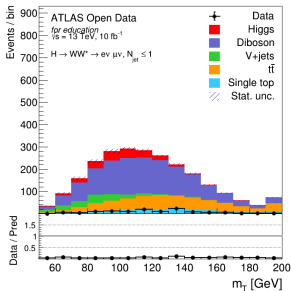
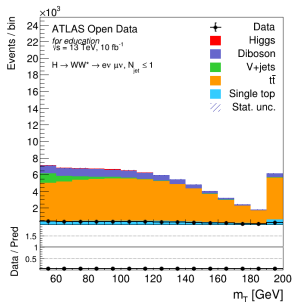
Event-selection criteria:

- Diphoton trigger satisfied
- Exactly two photons with $E_T > 35$ and 25 GeV, respectively
- Leading and subleading photon candidates are respectively required to have $\frac{E_t}{m_{\gamma\gamma}} > 0.35$ and 0.25
- $105 \text{ GeV} < m_{\gamma\gamma} < 160 \text{ GeV}$

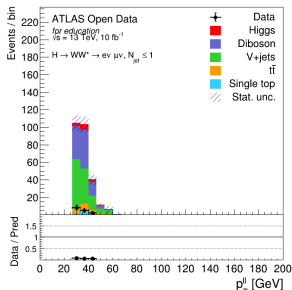
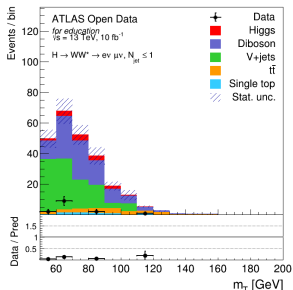
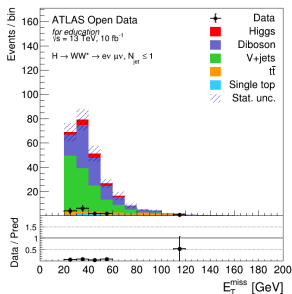
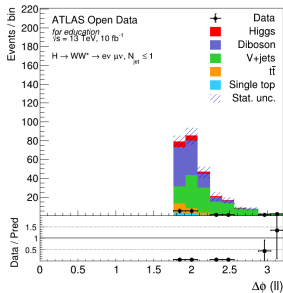
H \rightarrow WW*



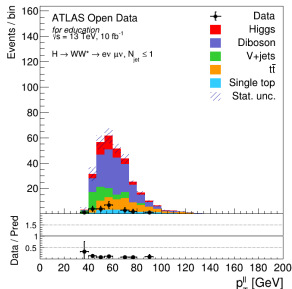
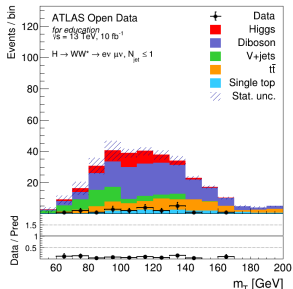
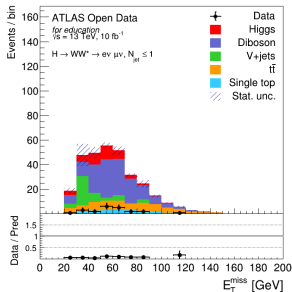
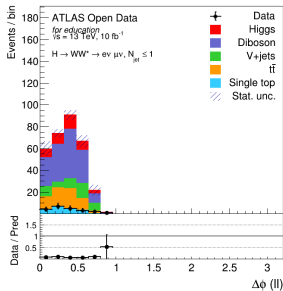
H \rightarrow WW*



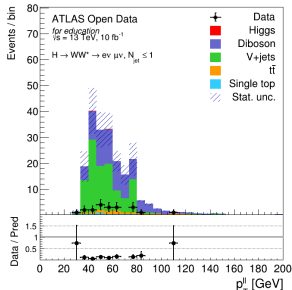
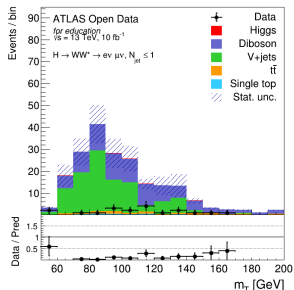
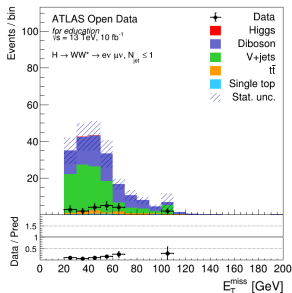
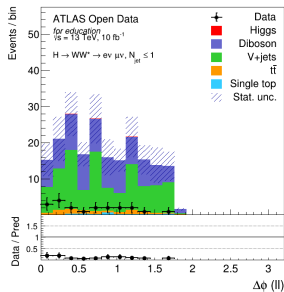
$H \rightarrow WW^* : d\Phi_{LL} > 1.8$



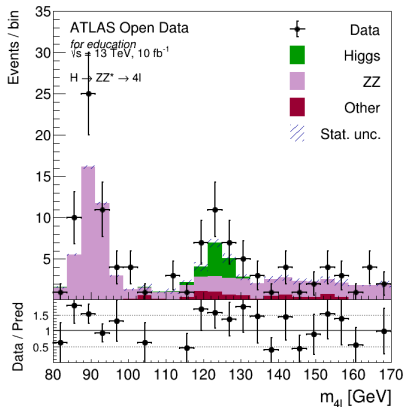
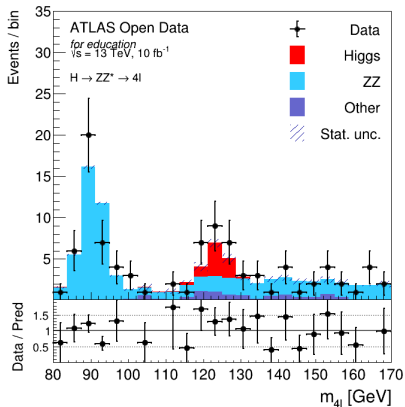
H \rightarrow WW* : 10 GeV < m_{LL} < 20 GeV



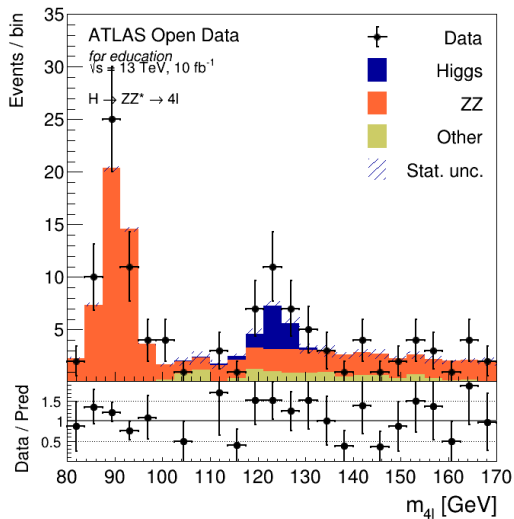
H \rightarrow WW* : leptons with the same sign

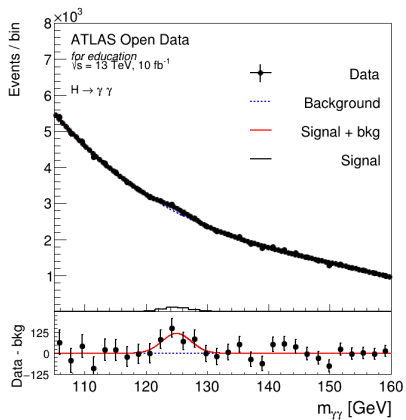


H \rightarrow ZZ*

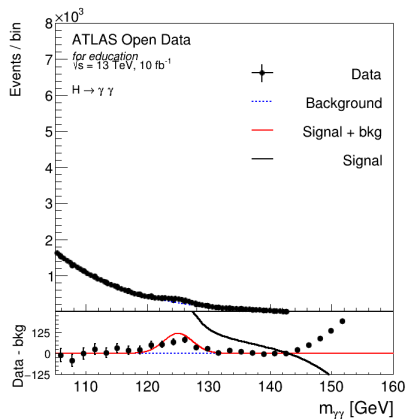
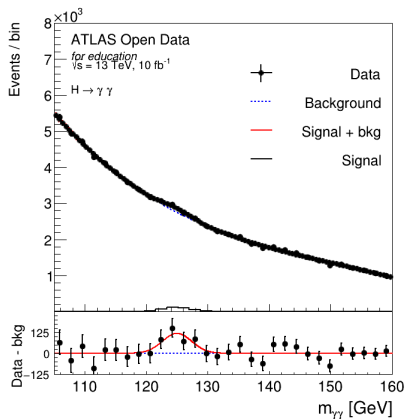


$H \rightarrow ZZ^*$

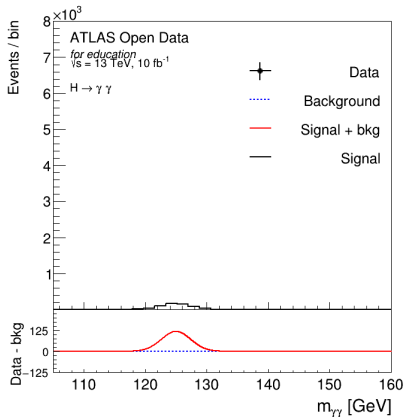
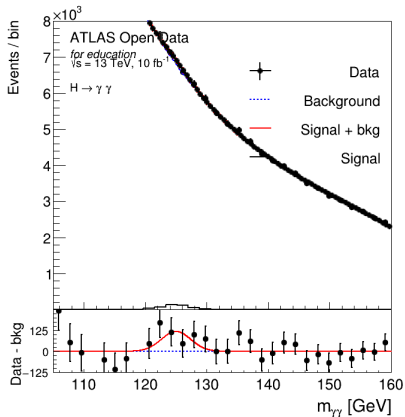




$H \rightarrow \gamma\gamma : E_T$ parameter



H \rightarrow $\gamma\gamma$: others parameters



Further studies on the selection and
particle identification criteria

Machine Learning

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