

DISSERTATION

**Automated optimization of sensitivity in
a search for boosted VBF Higgs pair
production in the $b\bar{b}b\bar{b}$ quark final state
with the ATLAS detector**

For the attainment of the academic degree doctor rerum naturalium

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Abstract

I am an abstract.

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0.1 The ATLAS experiment at the Large Hadron Collider

Exploring the nature of the Higgs particle requires collision energies on the TeV scale. The Large Hadron Collider (LHC) is currently the most powerful particle accelerator making it the best available facility for studying the Higgs particle. This section relies heavily on [1].

0.1.1 The Large Hadron Collider

The LHC is a circular proton proton collider with 27 km circumference with a center-of-mass energy of $\sqrt{s} = 13 \text{ TeV}$. The two anticyclic proton beams are actually bunches containing 10^{11} protons that are brought to collisions at several points of the ring for the experiments performed at the LHC. A measure of how tightly particles are packed in these bunches is the instantaneous luminosity and is characteristic to the collider

$$L = \frac{1}{\sigma} \frac{dN}{dt}. \quad (0.1.1)$$

It can be read as particle interactions per unit time and area. The area understood as the interaction cross-section of a particular process. The total recorded number of collision events is then with the integrated luminosity

$$N = \sigma \cdot \int L dt = \sigma \cdot L_{\text{int}}. \quad (0.1.2)$$

For the full run 2 dataset used in this thesis the integrated luminosity for events good for physics analysis is 140.1 fb^{-1} [2]. When bunches are collided not only one but rather several proton-proton interactions are measured. Methods to disentangle the different interactions in the detector improved over time so the mean number of interactions also called pile up increased during the data taking period as can be seen in figure 1.

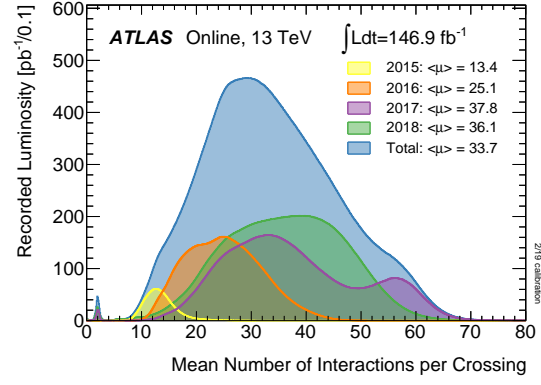


Figure 1: Pile up profiles for run 2 data taking periods [3].

0.1.2 ATLAS detector

where experiments are conducted and one of them is the A Toroidal LHC Apparatus (ATLAS) experiment.

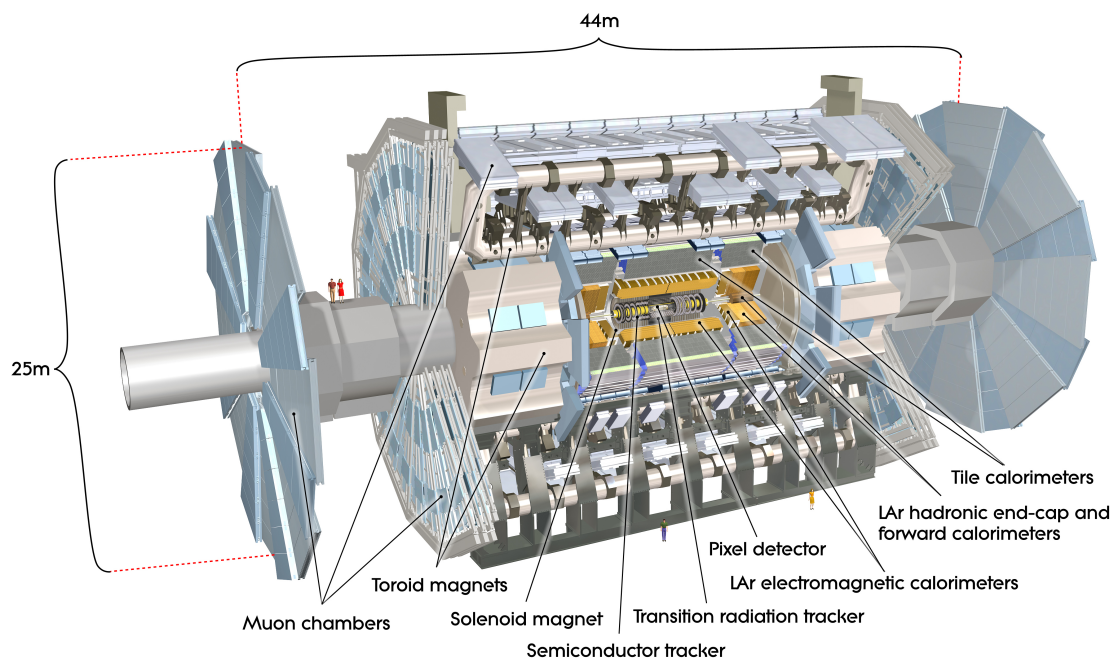


Figure 2

Appendix A

Acronyms

CERN Organisation européenne pour la recherche nucléaire

ATLAS A Toroidal LHC Apparatus

SM Standard Model

QFT Quantum Field Theory

QCD Quantum Chromodynamics

QED Quantum Electrodynamics

EW Electroweak

EWSB Electroweak Symmetry Breaking

VEV Vacuum Expectation Value

CKM Cabibbo-Kobayashi-Maskawa

LHC Large Hadron Collider

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- [2] ATLAS Collaboration. Luminosity determination in pp collisions at $\sqrt{s} = 13$ TeV using the ATLAS detector at the LHC. 2022. doi:10.48550/ARXIV.2212.09379.
- [3] ATLAS Collaboration. Luminosity Public Results for Run-2. URL <https://twiki.cern.ch/twiki/bin/view/AtlasPublic/LuminosityPublicResultsRun2>.

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