

University of California  
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# Constraints on the Higgs boson decay width from off-shell production decay into Z-boson pair

A dissertation submitted in partial satisfaction  
of the requirements for the degree

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in  
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by

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## Abstract

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The discovery of the Standard Model (SM) Higgs boson at the Large Hadron Collider (LHC) was a major achievement of the experimental particle physics community in the 21st century. Though a fair portion of the physics analysis focus has shifted to Supersymmetry (SUSY) physics, the direct search of SUSY models has yield null result so far. Meanwhile, the many properties of Higgs are still to be measured.

In this analysis, we present constraints on the decay width of Higgs boson,  $\Gamma_H$ , by using the on-shell and off-shell decay rates of Higgs to a pair of Z bosons and both Z's decay to a pair of electrons or muons. The result represent the expected constraints using the physics events and CMS experiment detector response simulated data via Monte Carlo methods (MC). The data and expected results correspond to run 2018 which has an integrated luminosity of  $59.7 \text{ fb}^{-1}$  at center-of-mass energy of 13 TeV.

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# Chapter 1

## Introduction

In this chapter I present a brief introduction of the LHC physics and the physics behind the off-shell methods for constraining Higgs decay width.

## 1.1 Physics at LHC

- LHC
- CMS (trigger, PF, anti-Kt)





## 1.2 The physics of off-shell methods

[1]Caola F, Melnikov K. Constraining the Higgs boson width with  $ZZ$  production at the LHC. Phys Rev D 2013;88:054024. <https://doi.org/10.1103/PhysRevD.88.054024>.





## 1.3 Background and signal simulation

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## 1.4 The CMS detector and event reconstruction

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# Chapter 2

## Methods

## 2.1 Event selection and physical variables

- Description of homebrew event variables and their physical significance
- DJJ\_VBF prescription



## 2.2 Backgrounds

- Remarks on a few ‘fakeable’ physical objects
- a interference background in Higgs sample
- Base plots of variables, justify some cuts

## 2.3 Signal simulation reweighting

- Physics of Higgs signal sample (the weight, ME)
- the need for piecing together samples with different LHE Mass
- procedures
- plots
- results (also see appendix A)









## 2.4 Strategy in variable selection and binning



1

# Chapter 3

## Results and interpretation





## Appendix A

### Weights Table for Higgs Sample











## Appendix B

### Additional Figures











# Bibliography