

Z+Jets differential cross-section measurement at 13TeV

Junho Lee Peking University, China On the behalf of CMS collaboration, LHC 2017/12/22



2

- Introduction & Motivation
- CMS structure
- Sample framework
- Event selection
- Data vs MCs
- Cross-section measurement
- Results
- Summary



CMS PAS SMP-15-010

PAS SMP-15-010 CMS Physics Analysis Summary

Contact: cms-pag-conveners-smp@cern.ch

2015/12/15

Introduction & Motivation

Measurement of the differential cross section of Z boson production in association with jets in proton-proton collisions at $\sqrt{s} = 13$ TeV

The CMS Collaboration

Abstract

Differential cross section measurements of the $Z(\rightarrow \mu\mu)$ boson production in association with jets are presented, using 13 TeV proton-proton collisions data recorded by the CMS detector at the LHC, corresponding to an integrated luminosity of 2.5 fb⁻¹. The cross sections are presented as a function of jet multiplicity, the jet transverse momenta, and the jet rapidity for different jet multiplicities. The cross section measurements are then compared with the predictions from a multileg next-to-leading-order Monte Carlo generator.

High cross-section

Low Background by requiring letonically decaying Z boson



rr je

between experiment and theory



Introduction & Motivation





Ring Ring



CMS structure



Sample framework

		Sample	XSec(pb)
	Signal :: (i) ZJets	DYJetsToLL_M-50_TuneCUETP8M1_13TeV-amcatnloFXFX- pythia8	1921.8*3
Single top	(ii) ttbar	TT_TuneCUETP8M1_13TeV-powheg-pythia8	831.76
	(iii) ST-†W	ST_tW_top_5f_inclusiveDecays_13TeV-powheg-pythia8_TuneCUETP8M1	35.6
	— (iv) ST-tW_anti	ST_tW_antitop_5f_inclusiveDecays_13TeV-powheg-pythia8_TuneCUETP8M1	35.6
	(v) ST_s	ST_s-channel_4f_leptonDecays_13TeV-amcatnlo-pythia8_TuneCUETP8M1	10.32
	(vi) WJets	WJetsToLNu_TuneCUETP8M1_13TeV-amcatnloFXFX-pythia8	61526.7
	(∨ii) WW	WWTo2L2Nu_13TeV-powheg	12.21
	(∨iii) WZ	WZJets_TuneCUETP8M1_13TeV-amcatnloFXFX-pythia8	4.4
	(ix) ZZ	ZZ_TuneCUETP8M1_13TeV-pythia8	15.4
	DATA	2015 DATA (13TeV)	2.5/fb

Sample Framework :: Signal MC

- MG5_aMC@NLO with FxFx merging scheme used, with di-lepton mass larger than 50GeV.
- The matrix elements include Z+0/1/2 partons NLO computation (3Jets maximum)
- The parton shower and hadronization are held by PYTHIA8
- The total cross section is normalized to the NNLO calculation by FEWZ

Event Selection

Preselection

- Di-lepton Mass > 50 GeV (Signal)
- Trigger applied on lepton(DATA)

Muon

- Two isolated Muons
- Particle Flow collection
- Global & tracker Muon
- PT > 20GeV
- |Eta| < 2.4

Z boson

- Reconstructed by two leading opposite Leptons
- Invariant mass between 71GeV to 111GeV

Jets

- Anti-KT(with R=0.4) algorithm applied
- PileUp suppressed by CHS & Jet Area Correction
- Isolated with leptons (R=0.4)
- Jet Energy Correction applied
- PT > 30GeV
- |Eta| < 2.4

DATA vs MCs

9



DATA VS MCS 10



DATA vs MCs



DATA VS MCS 12



Cross-Section Measurement

 Data Signal —> Unfolding —> back to particle level —> crosssection

No Detector effect (efficiency & resolution)

- "DATA Signal = DATA BKG_MCs Fake Fraction"
 - Fake Fraction : Signal MC Events passing with Reco but fail with Gen.
 - Particle/Generator(Gen) & Reconstructed(Reco) level of a event selected by applying cuts such as PT_lep, Eta_lep, Mll, Isolated Jets, PT_jet, Eta_jet, drlj.
- Unfolding
 - Input of the procedure : Signal Gen Hist, Signal Reco Hist, DATA Hist, BKG MC Hists, Signal Fake Hist.
 - Sig Reco Hist = Response Matrix * Sig Gen Hist



Cross-Section Measurement

- Unfolding
 - Response Matrix : migration probability between the Gen and Reco quantities obtained by Signal MC. (Sig Reco = Response Matrix * Sig Gen)
- Gen distribution with observables achievable by Response Matrix and Reco distribution.

(Data Signal Gen = Response $Matrix^{-1}$ * Data signal)

- Uncertainty of Jet energy correction, Integrated luminosity, and Cross-section uncertainty of MCs are considered.
- Compare theoretically estimated cross-section and obtained cross-section.
 - Observables : Jet Multiplicity, PTJets, HTJets, ETAJets



Result :: XSec by Jets Multiplicity





Result :: XSec by PT_Jets

16



Result :: XSec by HT_Jets



Result :: XSec by Eta_Jets



Summary

19

- Measurements of the cross-sections and differential cross sections for a Z boson produced in association with jets in pp collisions at a centre-of-mass energy of 13TeV are presented.
- The data correspond to an integrated luminosity of 2.5 fb-1 and were collected with the CMS detector during the 2015 proton-proton run with 25 ns bunch crossing at the LHC.
- Zjets Differential Cross-sections of observables : Jet multiplicity, pT and rapidities of the three leading jets, and HT for inclusive jets from one to three.
- The theoretically estimated cross-section corresponds within uncertainty of the measured cross-sections.

Thank you!