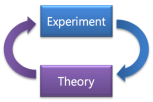
Z cross section measurement in the muon channel in pp collisions at √s= 8 TeV

Kyeongpil Lee, Kyungwook Nam and Hwidong Yoo
Seoul National University

<Motivation>

- Calibration of the detector: Clean signal with leptonic decays
  - Calibrate with the experimental Z cross section - trigger, identification, resolution, efficiencies, etc.
- Test perturbative QCD by precision measurement
  - PDF can be constrained by the experimental value

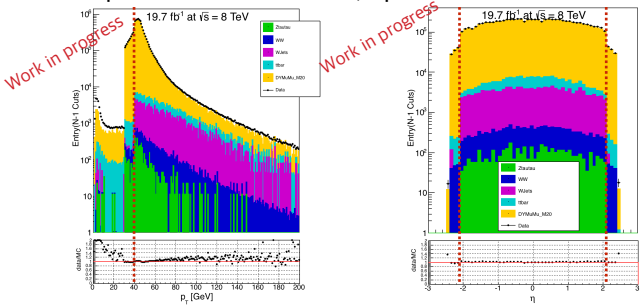


<Background Estimation & Obtain Signal Yields>

- Cross-section calculation

$$\sigma = \frac{N^{observed} - N^{background}}{Acceptance \times Efficiency \times Correction \times Luminosity}$$

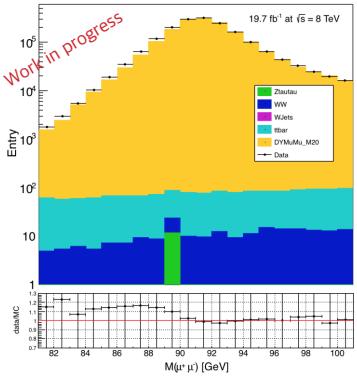
- Used Data/MC samples
  - Data: Run2012 Full dataset($\mathcal{L}$=19.7 fb^{-1})
  - MC simulation (Normalized to integrated luminosity)
    - Signal: Z/$\gamma^*(\rightarrow \mu\mu)$
    - Background: $t\bar{t}$, W+Jets, WW, Z/$\gamma^*(\rightarrow \tau\tau)$
- Event Selection
  - Trigger: High-pT single μ (pT>40 GeV, |η|<2.1)
    - Acceptance cuts: P_t>41 GeV, |η|<2.1



  - ID: Cuts based on TightID + Track Isolation

Variable	Condition	Variable	Condition
Muon type	Global Muon	χ^2/ndof of the global track	<10
# valid muon hits	>0	# Matched stations	>1
# valid hits in tracker layers	>5	# valid hits in pixel detector	>0
Vertical impact parameter w.r.t primary vertex	<0.2 cm	Horizontal impact parameter w.r.t primary vertex	<0.5 cm
(Relative)Track Isolation	<0.1		

  - Select events containing exactly 2 muons(opposite sign)
  - Mass window: 81 GeV < M < 101 GeV
- Invariant Mass Distribution



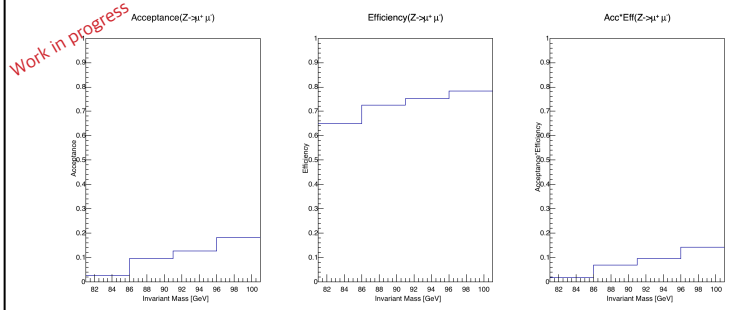
Type	# events
$N^{Observed}$	1788593
$N^{Backgrounds}$	1551 (ttbar:1337, WJets: 0, WW:202, Ztautau:12)

<Acceptance & Efficiency Estimation>

- Acceptance & Efficiency
  - To compensate for missing events due to the detector's kinematical limits and identification procedures
- Results

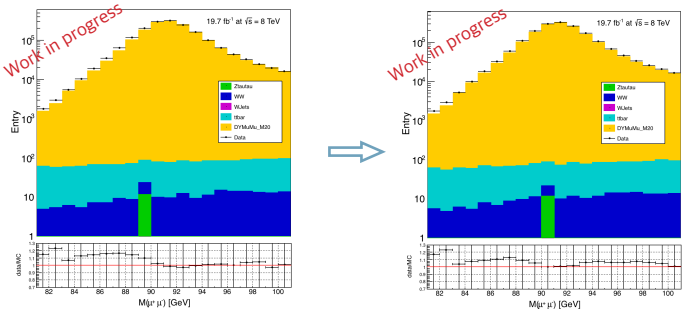
Type	value	Stat.Unc.
Acceptance	0.102	0.0002
Efficiency	0.744	0.001
Acc*Eff	0.076	0.0002

  - as a function of invariant mass



<Applying Corrections>

- Efficiency scale factor
  - Motivation: Efficiency obtained from MC simulation: dominant systematic uncertainty source
    ->Need a scale factor to take into account the difference between data and MC
  - Scale factor
    - ratio of the efficiency from data divided by the efficiency from MC
    - Use the official value obtained from Tag&Probe Method
- Muon momentum correction
  - Motivation: To compensate for the incorrect misalignment geometries in CMS reconstruction software
  - P_t correction based on <1/P_t> values is applied to correct the effect
- Effect of the corrections
  - Better agreement between data and MC after applying corrections



  - Changed signal yields & Effciency

Type	# events
$N^{Observed}$	1788593→1812185
$N^{Backgrounds}$	1551→1554

Type	value
Efficiency	0.744→0.736
Acc*Eff	0.076→0.075

<Result & Conclusion>

- Result

	Central value	Uncertainty(Stat.)	Uncertainty(Lum.)
x-section(nb)	1.220	0.003	0.032

  - CMS Published Value*
    - Experimental value: 1.16±0.02(stat.)±0.03(syst.)±0.03(lum.) (nb)
    - Theoretical prediction(NNLO): 1.13±0.04 (nb)
- Conclusion
  - Good agreement between experimental result and theoretical prediction
  - Reason of the difference with published result
    - different acceptance region used
    - did not include systematical uncertainty
    - did not take into account for γ^* contribution

*CMS Collaboration, "Measurement of inclusive W and Z boson production cross sections in pp collisions at √s=8TeV", Phys. Rev. Lett. 112(2014) 191802