

Università degli Studi di Perugia/INFN Perugia

LHCP Conference - May 17, 2013 W and Z boson production at CMS

Francesco Romeo

On behalf of the CMS collaboration

- W and Z inclusive cross-section at 8 TeV
- ullet Transverse momentum distribution of $Z \to \mu \mu$ at 8 TeV
- Differential Drell-Yan cross-section at 7 TeV
- Double Differential Drell-Yan cross-section at 7 TeV
- Charge asymmetry in inclusive W
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 u at 7 TeV

- W and Z events produce clean signals and allow high precision measurements
- Important test of the standard model (SM) of particle physics
- Significant contributions to Parton Distribution Function (PDF)
- Source of background for Higgs measurements, various SM processes (e.g.:*tt̄*, *diboson*), and beyond SM searches (e.g.: high mass dilepton resonances)
- Also used to understand the detector (efficiency measurements, lepton momentum scale and resolution)

- Analysis at 8 TeV [CMS PAS SMP-12-011] similar to analysis done at 7 TeV with L_{int} = 36pb⁻¹ [J. High Energy Phys. 10 (2011) 132]
- Data taking with dedicated LHC configuration
 - Separate the LHC beams in the transverse plane \rightarrow diminish the effective overlap \rightarrow low PileUp (\sim 5)
 - $\mathcal{L}_{inst} = 3 \times 10^{32} 6 \times 10^{32} \ cm^{-2} s^{-1}$; $\mathcal{L}_{int} = 18.7 \pm 0.9 \ pb^{-1}$
 - Special HighLevelTrigger (HLT) with low thresholds: 22 GeV for e and 15 GeV for μ

W and Z inclusive cross-section at 8 TeV ($W \rightarrow I\nu$)

Event selection

- Isolated electrons $E_T > 25 \text{ GeV}, |\eta| < 2.5$ (no 1.44< $|\eta| < 1.56$)
- Isolated muons $p_T > 25 \text{ GeV}, |\eta| < 2.1$
- Dilepton veto: no evt with a 2nd e, μ with E_T, p_T > 20,10 GeV

Signal extraction:

Fit $\not E_T$ with 3 contributions:

- W: MC template using boson recoil corrected from data
- QCD: analytic function
- 3 EWK: MC normalized to W through ratios of σ_{th}









W and Z inclusive cross-section at 8 TeV $(Z \rightarrow II)$

Event selection

- Isolated electrons E_T >25 GeV, $|\eta|$ <2.5 (no 1.44< $|\eta|$ < 1.56)
- Isolated muons $p_T > 25$ GeV, $|\eta| < 2.1$
- 60 GeV $< M_{ee,\mu\mu} <$ 120 GeV

Signal extraction:

Out and count



W and Z inclusive cross-section at 8 TeV



Electron and muon channel results consistent Good agreement with theoretical NNLO predictions

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14

18.7 pb⁻¹ at √s = 8 TeV

7.32 ± 0.20 nb

HH

18.7 pb⁻¹ at √s = 8 TeV

1 13 ± 0 04 nb

 $\sigma(pp \rightarrow Z) \times BR(Z \rightarrow II) [nb]$

H-Hel

Transverse momentum distribution of $Z \rightarrow \mu\mu$ at 8 TeV [CMS-PAS-SMP-12-025]





- Comparison with theory after unfolding procedure correcting for detector resolution and final-state radiation
- Normalization to cross-section in the restricted detector acceptance
- Better agreement with Resbos and Madgraph than with Powheg

Differential Drell-Yan cross-section at 7 TeV [CMS-PAS-SMP-13-003]



- Unfolding procedure and Normalization to Z-peak region (60 < M < 120 GeV)
- Good agreement with the NNLO theoretical predictions (CT10) as computed with FEWZ 2.1.1

Double Differential Drell-Yan cross-section at 7 TeV



- Unfolding procedure and Normalization to Z-peak region (60< M <120 GeV)
- All predictions relatively close to each other and good agreement with data in peak region
- The measurement provides constraints on $q\bar{q}$ PDF and can be used for new generation of PDF

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Charge asymmetry in inclusive $W \rightarrow e\nu$ at 7 TeV [Phys. Rev. Lett. 109 (2012) 111806]

In *pp* collisions, *W* produced primarily via $u\bar{d} \to W^+$ and $d\bar{u} \to W^-$. *p* has 2 u and 1 d \to more W^+ than $W^ \mathcal{A}(\eta) = \frac{d\sigma/d\eta(W^+ \to l^+ \nu) - d\sigma/d\eta(W^- \to l\bar{\nu})}{d\sigma/d\eta(W^+ \to l^+ \nu) + d\sigma/d\eta(W^- \to l\bar{\nu})}$



Data are in agreement with the predictions, except that MSTW2008NLO is systematically lower in $|\eta|<\!\!1.4$ Significant contributions to PDFs for valence and sea u,d quarks

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Charge asymmetry in inclusive $W \rightarrow \mu \nu$ at 7 TeV [CMS-PAS-EWK-11-005]



Data exhibit flatter variation of asymmetry with $|\eta|$ than MSTW2008NLO, CT10W, and NNPDF2.1 (NLO) PDF sets Significant contributions to PDFs for valence and sea u,d quarks

Conclusions

- Showed measurements of inclusive W and Z boson cross-section, transverse momentum distribution, Drell-Yan differential and double differential cross-section, and lepton charge asymmetry performed with CMS detector
- Important test of the standard model (SM) of particle physics
- Significant contributions to proton PDFs
- Looking forward for more 8 TeV results and 14 TeV results



• For all CMS public results [click here]