Determination of photon PDF from High Mass Drell Yan data at LHC

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(Dated: November 15, 2016)

abstract goes here: ...

CONTENTS

I. INTRODUCTION

II. THEORY

Two processes contribute to opposite sign, same family, dilepton production at the LHC: the Drell-Yan quark-antiquark process and the photon-induced process. Both the contributions can be simulated with MadGraph5_aMC@NLO (version 2.4.3) and interfaced to APPLgrid (version 01-04-70) and aMCfast (version 01-03-00). A special release of APPLgrid is used to account for the photon PDF within the proton *need references for the programmes*. Both contributions are generated in the 5-flavour scheme, where all the quarks, except for the *top* quark, are treated as massless quarks; all the calculations are performed at fixed-order (FO) without parton showers.

Theoretical predictions for both the one-dimensional $\frac{d\sigma}{dm_{ll}}$ distribution (where m_{ll} is the invariant mass of the dilepton pair in the final state) and the double-differential distributions $\frac{d^2\sigma}{dm_{ll}d|y_{ll}|}$ (where $|y_{ll}|$ is the rapidity of the dilepton pair) and $\frac{d^2\sigma}{dm_{ll}\Delta\eta_{ll}}$ (where $\Delta\eta_{ll}$ represents the difference in pseudorapidity between the two leptons) are generated for both the electron and the muon channels.

These predictions are generated using the same selections as in reference [**?**] as follows:

- the invariant mass of the lepton pair is required to be greater than 116 GeV;
- the absolute value of the pseudorapidity of each lepton is required to be less than 2.5;
- the transverse momentum (p_T) of the leading lepton has to be greater than 40 GeV;
- the p_T of the sub-leading lepton has to be greater than 30 GeV.

The binning used is the same as used in reference [**?**]. For the invariant mass distribution, there are 12 bins between 116 GeV and 1.5 TeV with variable bin widths; and for both of the the two-dimensional distributions, there are five different histograms, each one for a different invariant mass range: (a) 116 GeV $< m_{ll} <$ 150 GeV; (b) 150 GeV $< m_{ll} <$ 200 GeV; (c) 200 GeV $< m_{ll} <$ 300 GeV; (d) 300 GeV $< m_{ll} <$ 500 GeV; (e) 500 GeV $< m_{ll} <$ 1500 GeV. The APPLgrids for the first three m_{ll} intervals are divided into 12 bins with fixed bin width between $|y_{ll}^{mim}|$ ($|\Delta\eta_{ll}|$) = 0.0 (0.0) and $|y_{ll}^{max}|$ ($|\Delta\eta_{ll}|$) = 2.4 (3.0), while the final two m_{ll} intervals are divided into 6 bins with fixed bin width scanning the same $|y_{ll}|$ and $|\Delta\eta_{ll}|$ ranges.

Dynamical renormalization (μ_R) and factorization (μ_R) scales are used in the calculations and both are set to m_{ll}. The theoretical calculations were validated by comparing both the NLO QCD + LO EW predictions and the LO PI predictions to those computed using the FEWZ 3.1 framework. These calculations are evaluated in the G_F electroweak scheme, with the following values for the couplings: $\alpha_S = 0.118$; $1/\alpha_{EW} = 1/127$. The difference between the two predictions is at most 1%, for both the 1-dimensional and the 2-dimensional distributions.

In order to make a next-to-next-to-leading order (NNLO) fit k-factors (k_F) are computed matching the NLO QCD + LO EW cross sections to higher order (HO) calculations. These are computed using FEWZ, with the same input parameters as for the NLO computations. The k_F are defined as:

$$k_F = \frac{NNLO\ QCD + NLO\ EW\sigma}{NLO\ QCD + LO\ EW\sigma} \tag{1}$$

The MMHT2014NNLO PDF set is used to compute both numerator and denominator. The k_F are close to the unity and their variation is $\sim 2\%$. *provide Table of Final k-factors?*

Discuss theory improvements: addition of the NLO QED+QCD piece

III. RESULTS

A. Sensitivity

show impact of HM DY on PDFs using sensitivity studies based on pseudo-data, for which we only use the data uncertainties, while central value are fixed: HERA I+II vs HERA I+II + HMDY –> see the sensitivity plots from the previous email

conclusion: HMDY data has a large impact on photonPDF

B. Reweighting

proceed to reweighting of the global photon PDFs : $NNPDF3.0\_nnlo\_qed$

–> see the reweighting plots (select only the NNPDF3.0nnlo qed from the previous email)

perhaps add a chi2 table for various global PDF sets on the market to check the agreement between HMDY data and predictions: CT14qed, NNPDF3.0qed, LUXqed...

conclusion: HMDY can considerably reduce the uncertainties on photonPDF for global PDFs

C. Fits

–> extract PDFs using HMDY +HERA data? and plot it in comparison with global QED PDF sets (reweighetd)?

IV. CONCLUSIONS