Doubly-polarised WZ production at the LHC: an update

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Process: $pp \rightarrow e^+ \nu_e \mu^+ \mu^- + X$.

Accuracy: NLO QCD.

Code: MoCaNLO Monte Carlo integrator, interfaced with Recola+Collier.

Details: $N_F = 5$, G_μ-scheme for α, complex-mass scheme for weak bosons.

PDFs.: NNPDF3.1 at (N)LO with $\alpha_s(M_Z) = 0.118$, LHAPDF interface.

Ren. and fact. scale: $\mu_R = \mu_F = (M_Z + M_W)/2$.

- **fiducial region:** $p_{T,e^+} > 20\,\text{GeV}$, $p_{T,\mu^\pm} > 15\,\text{GeV}$, $|y_\ell| < 2.5$, $\Delta R_{\mu^+\mu^-} > 0.2$, $\Delta R_{\mu^\pm e^+} > 0.3$, $M_{T,W} > 30\,\text{GeV}$, $81\,\text{GeV} < M_{\mu^+\mu^-} < 101\,\text{GeV}$.

Full process: σ_F (all off-shell, interferences).

Unpolarized signal: σ_U (DPA, unpolarized).

Singly-polarized signals: σ_λ (DPA, $W_\lambda Z_U$ or $W_U Z_\lambda$, $\lambda = L, T$).

Doubly-polarized signals: $\sigma_{\lambda\lambda'}$ (DPA, $W_\lambda Z_{\lambda'}$, $\lambda = L, T$).

Non-resonant background: $\sigma_F - \sigma_U$.

Interferences among pol. states: $\sigma_U - \sum_\lambda \sigma_\lambda$ or $\sigma_U - \sum_{\lambda,\lambda'} \sigma_{\lambda\lambda'}$.

Several observables and MC truth variables already studied in NLO QCD distribution, K-factors, polarization fractions, and normalized distribution shapes.

NN-based variables (F. Costanza, G. Pelliccioli)

Need to make MoCaNLO compute the NLO distribution for the output of a Neural Network (NN) built with Keras: both for neutrino momentum reconstruction and for other NN-based variables.

MoCaNLO written in `fortran90`, Keras libraries written in `python`.

The strategy is to:

▶ interface MoCaNLO with Keras via FKB libraries (Fortran-to-Keras Bridge arXiv:2004.10652[cs.LG]), such that the histogram module of MoCaNLO can load the NN modules

▶ put the NN-model trained with Keras layers in a structure that is compatible with FKB interface.

Work in progress.

Next steps

Missing steps to be done/solved (from last meeting list of questions):

- Improving neutrino reconstruction? Can we do better? $\rightarrow$ with or without NN
- Fiducial region additional cuts?
- Other observables? $\rightarrow$ NN output
- Comparison with other theory predictions? $\rightarrow$ LO avaliable
- Binning/format of SM templates?