CMEPDA exam Abstract:
Measurement of the forward-backward asymmetry of Drell–Yan events in pp collisions at 8 TeV

Sara Gamba
Giulia Nigrelli

January 2023

A library has been designed to reproduce the analysis of the weak mixing angle using the forward-backward asymmetry of Drell-Yan muon pairs produced in proton-proton collisions at $\sqrt{s} = 8$ TeV at CMS experiment of the LHC (More information at: [1]). The data correspond to an integrated luminosity of 18.8 fb^{-1}. The analysis provides a comparison between the data recorded by the CMS experiment and those obtained from the Monte Carlo simulations of collision events. The library produces the invariant mass distribution of the muon pairs, their angular distribution and also the forward-backward asymmetry. The first two analyses are performed for three dimuon pseudorapidity ranges: $0.0 < |y_{\mu\mu}| < 0.4$, $0.8 < |y_{\mu\mu}| < 1.2$, $1.6 < |y_{\mu\mu}| < 2.0$, while for the last 6 ranges have been used; $0.0 < |y_{\mu\mu}| < 0.4$, $0.4 < |y_{\mu\mu}| < 0.8$, $0.8 < |y_{\mu\mu}| < 1.2$, $1.2 < |y_{\mu\mu}| < 1.6$, $1.6 < |y_{\mu\mu}| < 2.0$, $2.0 < |y_{\mu\mu}| < 2.4$. The library also allows to filter the input data to make them readable by the developed functions.

We initially imported Monte Carlo and Run datas from CMS open data site and we have filtered them:

1. Muon number trigger: $n_\mu = 2$;

2. Charge trigger: $Q_{\mu,1} \cdot Q_{\mu,2} = -1$;

3. Rapidity trigger: $|\eta| < 2.4$;

4. Transverse momentum trigger: $p_{1,T} > 25$ GeV and $p_{2,T} > 15$ GeV or viceversa;

5. Transverse distance trigger: $d_{xy} < 0.2$ cm;

6. Muon isolation trigger: $Iso_{1,2} < 10\% \ p_T$;

We have then created two files with Snapshot function: one for MC filtered datas and the other with Run filtered datas. The two snapshots create two .root files, in a folder named datas, with a dataframe of 4 columns:

1. Trasversal momentum of the two muons ($Muon\_pt$);

2. Pseudorapidity of the two muons ($Muon\_\eta$);

3. Coordinate phi of the two muons ($Muon\_\phi$);

4. Mass of two muons ($Muon\_mass$).

This files are recalled in three different macros that provide three different analysis:

1. Dimuon mass Spectrum of Z;

2. Histogram of $cos(\theta^*)$;

3. Asimmetry forward-backward.

The quantities to be analyzed are calculated by manipulating the dataframes and the results are shown through the production of normalized histograms with respect to the total number of events. In each histogram both Run data and MC data are shown in order to compare them. At the end the user can find the chosen analysis in the images folder and in the subfolder named as the analysis.

The compilation and the execution is done with python3. The whole analysis software is written in C++, using ROOT 6.26 libraries.

References

[1] Albert M. Sirunyan et al. "Measurement of the weak mixing angle using the forward-backward asymmetry of Drell-Yan events in pp collisions at 8 TeV". In: *Eur. Phys. J. C* 78.9 (2018), p. 701. DOI: 10.1140/epjc/s10052-018-6148-7. arXiv: 1806.00863 [hep-ex].