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

Sara Gamba
Giulia Nigrelli

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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. The analysis provides a comparison between the data recorded by the CMS experiment and those obtained from the Monte Carlo simulations of collision events. In particular the software produces the mass distribution of the muon pairs and 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 have tried to reproduce the analysis on this article: https://arxiv.org/abs/1806.00863.

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 $p_{2,T} > 15\ Gev$;
5. Transverse distance trigger: $d_T < 0.2\ cm$;
6. Muon isolation trigger: $Iso_{1,2} < 10\% p_T$;

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

1. Trasversal momentum of the dimuon ($Muon_{pt}$);
2. Pseudorapidity of the dimuon ($Muon_\eta$);
3. Coordinate phi of the dimuon ($Muon_\phi$);
4. Mass of dimuon ($Muon_{mass}$).

Then we have done three different analysis:

1. Dimuon mass Spectrum of Z;
2. Histogram of $cos(\theta^*)$;
3. Asimmetry forward-backward.

The first is done by calculating dimuon mass, from our filtered columns, and then making two normalized (by the total number of events) histograms of MC events and Run events. The second is done by calculating $cos(\theta^*)$ and making two normalized (by the total number of events) histograms of MC and Run events. The third is done by calculating A_fb, only of MC events, from four 2D histograms of the quantities written in the article.

The compilation is done with python3, and all the programs are in C++. It uses ROOT 6.26 libraries.