Computational Particle Physics , Jan-May 2025

End-Sem

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1. Using the ROOT file exam.root:
   a. Find the number of events (or entries) stored in the file and include that information in your report.
   b. Plot the number of muons, number of electrons, pT (up to 150 GeV), eta, phi of the particles.

   [10]

2. Using the ROOT file exam.root:
   a. Produce an output ROOT file containing only the muon pT information stored in a branch with name the same as your name and the output file should also have the same name.
   b. In the report, note the difference in size between the two files.

   [10]

3. Using the ROOT file exam.root:
   a. Create the invariant mass of two leading (in pT) muons if they are of opposite charge and have a PT of above 10 GeV and store the distribution as a histogram. Fit the histograms in a suitable range around the Z mass using a gaussian function and note the resolution and resolution error. Include the plots in your report.
   b. Do the same for Muons and Electrons for events that have both at least 2 muons and 2 electrons. Can you guess which kind of events are simulated here?

   [10]

4. Use the exam.lhe file attached with DELPHES to simulate the detector reconstruction of the events in
   a. CMS detector using the card: cards/delphes_card_CMS.tcl in your Delphes directory. Use DELPHES ROOT based visualization to visualize the event number corresponding to the final digit of your roll number in the CMS detector and attach screenshots in your report.
   b. ATLAS detector using the card: cards/delphes_card_ATLAS.tcl in your Delphes directory. Attach visualisation similarly as for the previous part.
   c. Plot the invariant mass of the first two Muon s for events with these objects separately for the two detectors and include the two in your report.
   d. Can you guess which kind of events are simulated here (you may take into account electron and muon information)?

   [10]

5. Using the DELPHES interface with PYTHIA8:
   a. Simulate the number of events corresponding to the last 4 digits of your roll number for the ttbar (top-antitop) production process at the LHC at the center of mass energy of 14 TeV and run it through the ATLAS detector simulation.
   b. Use DELPHES ROOT based visualization to visualize the event number corresponding to the final digit of your roll number in the ATLAS detector and attach screenshots in your report.

   [10]