FYSS4456: Experimental methods in particle physics, fall 2017 Project work

The goal of the project work is to do a semi-blind analysis of neutral pion reconstruction based on the PYTHIA data. The data files contains TTree with branches for final charged hadrons and (energy smeared) final photon spectra. However, the full Monte Carlo truth is not available. The folder /automisc/data/FYSS4456/ProjectWork contains a two test files from which to start the analysis. Folder AnalysisFiles contains the files from which the final analysis should be done.

This project work is build on exercises 6. You need also techniques given in exercises 2 related to reading a TTree. I recommend to take the code ExerciseSession6.C as a starting point, unless you did a better answer to the exercise question than my example solution. From the code, wipe out all that is related to PYTHIA and replace that with TTree reading and looping routines from exercises 2.

Follow the lecture 10 on neutral pion reconstruction. One particular remark: everybody is expected to use binning 0.5, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, 10.0, 12.0, 15.0, 20.0 for the $\pi^0 - p_{\mathrm{T}}$.

Read the README file from the folder.

Questions state the steps that you will take:

1. Modify the code such that, instead of PYTHIA, it reads in the given root-file, takes there the TTree and loops over that.

2. Test first that the analysis done in exercise session 6 can be reproduced on the relevant parts. Note here that the calorimeter acceptance is smaller and the full Monte Carlo information is not available. For example, you cannot fill π^0–histograms.

3. Construct a better mixed event routine that has a pool depth as an input parameter. Make final analysis for example with $N = 5$.

4. Construct the real and mixed event distributions for invariant mass distributions in the neutral pion p_{T} bins.

5. **This step is done in the final analysis, once everything is well tested and works**. There are 10 files in the AnalysisFiles –folder, each containing 500 k event. Run your analysis over all of the 10 files and you will get out 10 root-files. Merge the output root-files with command that you give in terminal, not in root:

   hadd outputFile.root inputFile1.root inputFile2.root ... inputFileN.root

   Make the merged file before the mixed event subtraction and further analysis of the signal peak. Note: you do not need to copy the files. You can give a path to TFile::Open -command and **use "read" option** to avoid accidents.

6. Subtract mixed event and fit the π^0 signal peak and fit the signal again in the p_{T} bins. From the fit, take the number of neutral pions in that bin.

7. Construct neutral pion p_{T}–spectrum to TGraphErrors such that the x-value is taken to be a mean p_{T} inside a bin and the x–axis errors represent the bin widths. Then y–axis is yield of π^0's. Note the proper normalizations from the acceptance!

8. Plot to same Figure your result and p_{T}–spectrum of charged hardrons. Try to judge the result based on the ratio that you calculated in the exercises 6.

9. Save Figures from ROOT and make a small note/Powerpoint presentation where you put the final Figures and a caption where you explain what is in Figure. Maybe a few sentences explanation when needed, but no need to write a lenghtly text.

10. Return your presentation and the code that you wrote, then the course is done. :)