



## COMPUTING EXERCISE

### Study of the production of a pair of gauge bosons at the LHC

The data to analyse are organised into a Root n-tuple (which we will provide to you). The Root n-tuple is a file containing information about "events", each resulting from a proton-proton interaction. These events have three leptons (electrons or muons) and are of two kind:

**SIGNAL EVENTS:** corresponding to  $pp \rightarrow WZX$  with both boson disintegrating leptonically ( $X$  stands for non identified generic particles ),

**BACKGROUND EVENTS:** top-antitop events  $pp \rightarrow t\bar{t}X$ .

Since this ntuple is built from a MC file, the two kind of events appear in two separated 'trees' called here "WZSignal" and " $t\bar{t}$ ". For real data these events appear in the same tree and it is important to devise variables to distinguish between them.

The aim of the exercise is :

- 1) to look at some important variables,
- 2) to build the  $Z$  invariant mass,
- 3) to learn how one can discriminate between the 'signal' and the 'background' (*we will provide an example of analysis to guide you*)

Exercise:

- Open the Root file ( the name of the file is *Selected\_All\_EEM.root*)
- Access the branch WZSignal and  $t\bar{t}$  (use, as guide the macro *Macro.C*) The list of variables describing the event are given at the end of this document.
- Plot the transverse momentum of the most energetic  $Z$  lepton for signal and background. (Note the average value and the shape of each distribution)
- Compute and plot the invariant mass of the  $Z$  for ALL events (using the decaying leptons)
- Plot the isolation variable TrackIsoWmu separately for signal and bkg. Is there a difference? How can one discriminate between signal and background?
- Plot the impact parameter variable Trackd0cutWMu for signal and bkg. Is there

a difference? How can one discriminate between signal and background?

- Plot the Z invariant mass for ALL events requesting that the third lepton has a small impact parameter and is isolated.

- Compare the Z invariant mass with the one in the tree.

- OPTIONAL: Fit the MZ distributions with a Breit-Wigner and extract the fraction of signal events in the total sample.

---

List of Variables in the ntuple

Br 0 :Trackd0cutWMu : Trackd0cutWMu

Br 1 :TrackIsoWmu : TrackIsoWmu

Br 2 :MET : MET

=== MASS of Z

Br 3 :MZ : MZ

=== MOST ENERGETIC LEPTON FROM THE Z

Br 4 :pt1 : pt1

Br 5 :eta1 : eta1

Br 6 :phi1 : phi1

Br 7 :E1 : E1

=== SECOND ENERGETIC LEPTON FROM THE Z

Br 8 :pt2 : pt2

Br 9 :eta2 : eta2

Br 10 :phi2 : phi2

Br 11 :E2 : E2

=== LEPTON FROM W

Br 12 :pt3 : pt3

Br 13 :eta3 : eta3

Br 14 :phi3 : phi3

Br 15 :E3 : E3

Br 16 :Weight : Weight