QuarkNet Masterclass Particle Analysis - CIMA

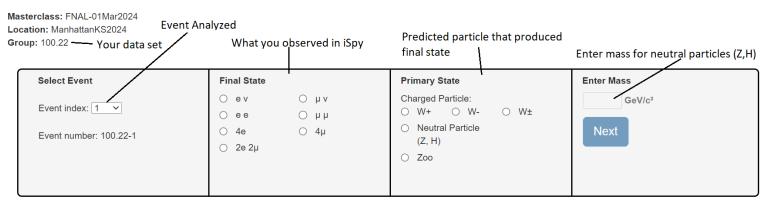
#### Set-up

For this activity, you will work with a partner. Each person will need:

- A laptop with internet connection
- Data Analysis Handouts
- One person in the group will need to go to the CIMA website at <a href="https://www.i2u2.org/elab/cms/cima-wzh/">https://www.i2u2.org/elab/cms/cima-wzh/</a>
- Find our Masterclass Center FNAL and date, 01Mar2024 and click on it to select it. Find the ManhattanKS2024 location at the top of the middle column and click on it to select. Look for the data set assigned to you and your partner and click on it to load that data file.

| TestEvents-01Jan2022         CDMX_lbero2024         100.1           Santander-13May2024         ManhattanKS2024         100.11           CERN-27Nov2023         100.12           Salo-07Dec2023         100.13           Sofia-13Dec2023         100.14           CERN-LAMAP-08Dec2023         100.15           MP-15Jan2024         100.16           Cakovec-24Jan2024         100.17           Bristol-27Mar2024         100.18           CERN-09Feb2024         100.19 |
|---|
| CERN-27Nov2023       100.12         Salo-07Dec2023       100.13         Sofia-13Dec2023       100.14         CERN-LAMAP-08Dec2023       100.15         MP-15Jan2024       100.16         Cakovec-24Jan2024       100.17         Bristol-27Mar2024       100.18  |
| Salo-07Dec2023       100.13         Sofia-13Dec2023       100.14         CERN-LAMAP-08Dec2023       100.15         MP-15Jan2024       100.16         Cakovec-24Jan2024       100.17         Bristol-27Mar2024       100.18  |
| Sofia-13Dec2023       100.14         CERN-LAMAP-08Dec2023       100.15         MP-15Jan2024       100.16         Cakovec-24Jan2024       100.17         Bristol-27Mar2024       100.18  |
| CERN-LAMAP-08Dec2023       100.15         MP-15Jan2024       100.16         Cakovec-24Jan2024       100.17         Bristol-27Mar2024       100.18   |
| MP-15Jan2024 100.16 Cakovec-24Jan2024 100.17 Bristol-27Mar2024 100.18   |
| Cakovec-24Jan2024       100.17         Bristol-27Mar2024       100.18   |
| Bristol-27Mar2024 100.18  |
|   |
| CERN-09Feb2024 100.19   |
|   |
| Sandbox-31Dec2023 100.2   |
| CERN-20Feb2024 100.21   |
| CERN-26Feb2024 100.22   |
| CERN-29Feb2024 100.23   |
| CERN-22Feb2024 100.24   |
| CERN-01Mar2024 100.25   |
| CERN-04Mar2024 100.3  |
| CERN-06Mar2024 100.4  |
| CERN-08Mar2024 100.5  |
| CERN-11Mar2024 100.6  |
| CERN-13Mar2024 100.7  |
| CERN-19Mar2024 100.8  |
| CERN-22Mar2024 100.9  |
| CERN-27Mar2024 25.1   |
| FNAL-01Mar2024 25.11  |

## **Recording Particles Observed in iSpy**

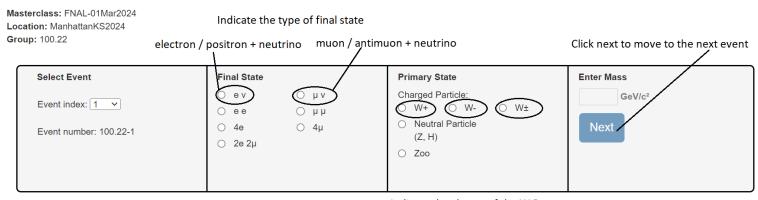


e - electron/positron v -neutrino/antineutrino  $\mu$  - muon /antimuon

#### **Charged Particles - W Bosons**

- W Bosons decay into either an electron / positron, or a muon / antimuon and a neutrino / antineutrino
- The neutrino / antineutrino will be indicated by a missing energy (Solid Pink Vector)
- The electron / positron track (green line) will not go past the Ecal barrel (the first ring) and will curve counterclockwise if it is negative and clockwise if it is positive
- The muon / antimuon track (red line) will continue through the Hcal barrel (second ring) and will curve counterclockwise if negative and clockwise if positive

### What do you record?

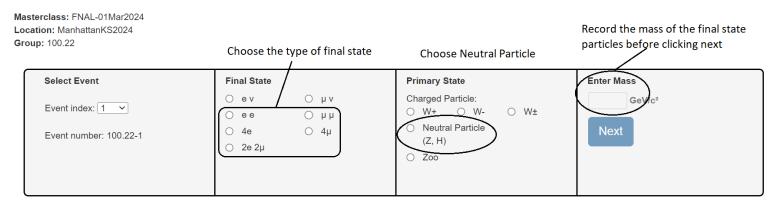


Indicate the charge of the W Boson Based on direction final state curved: W+ (Clockwise), W- (Counterclockwise), W+/- if you couldn't tell

# **Neutral Particle (Z, & Higgs Bosons)**

- **Z Bosons** decay into a pair of leptons: either a **electron + positron** (two green tracks curving opposite directions) or muon + antimuon (two red tracks curving opposite directions)
- Higgs Bosons will decay into two Z Bosons, which then decay into two lepton pairs. So the final state will include 4 electron / positron (4 green tracks), or 4 muon / antimuon (4 red tracks), or 2 electron / positron + 2 muon / antimuon (2 green tracks + 2 red tracks)

# What do you record?



#### None of the Above:

- If the event does not match one of the categories above, then look at the **pt of the tracks (click once)**. If the pt is less than 20eV you may consider ignoring it and analyzing the event based on the tracks that remain.
- As a last resort...enter Zoo if the event does not fit into any of the categories above.