Physics
QuarkNet Masterclass Particle Analysis

## Set-up

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

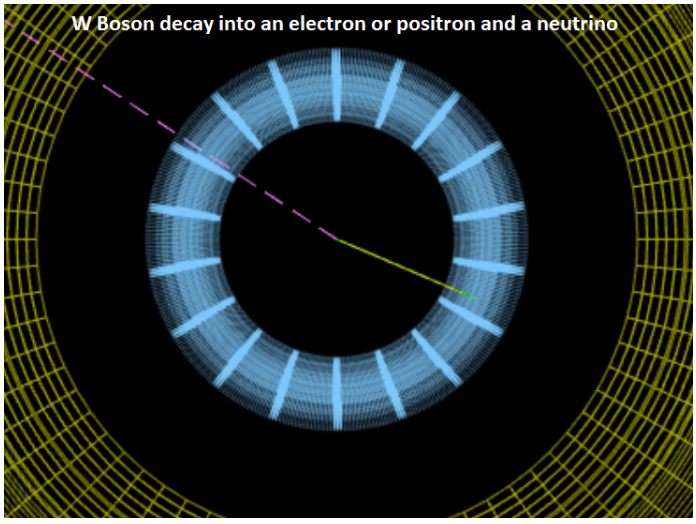
- A laptop with internet connection
- Data Analysis Handout
- One person in the group will need to go to the **iSpy** event analysis website at http://www.i2u2.org/elab/cms/ispy-webgl/
- Use the "open" tab to load the events assigned by your instructor.
- Check the following options: **ECAL Barrel**, **HCAL Outer**, **Event**, **Electron Tracks**, and **Missing Et**.
- The other person in the group will need to go to the **CIMA** website at https://www.i2u2.org/elab/cms/cima/index.php
- Choose your masterclass assigned by your instructor

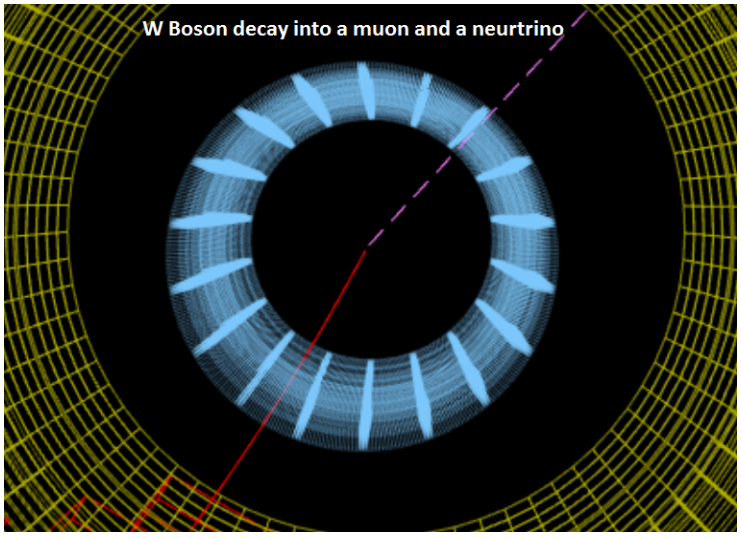
## Analysis

Use the information below to identify the particles produced during your assigned events.

## W Bosons

- **W Bosons** decay into a lepton (an electron, positron, muon **or** an antimuon) **and** a neutrino.
- The **neutrino** will be indicated by a **missing energy** (pink dashed line) usually **greater than 20 GeV.**
- The **electron** track (green line) will not go past the **Ecal barrel** (the first ring) and will **curve counter clockwise** because it is negatively charged.
- The **positron** track (green line) will not go past the **Ecal barrel** (the first ring) and will **curve clockwise** because it is positively charged.
- The **muon** track (red line) will continue through the **Hcal barrel** (second ring) and will curve either **clockwise if positive** or **counterclockwise if negative**.



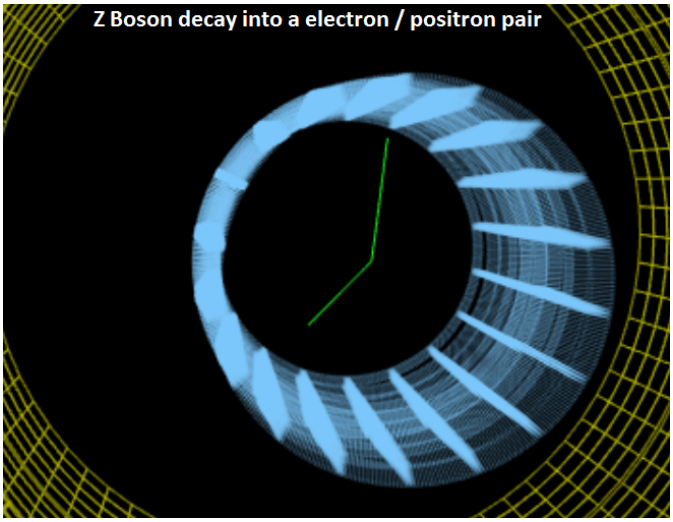



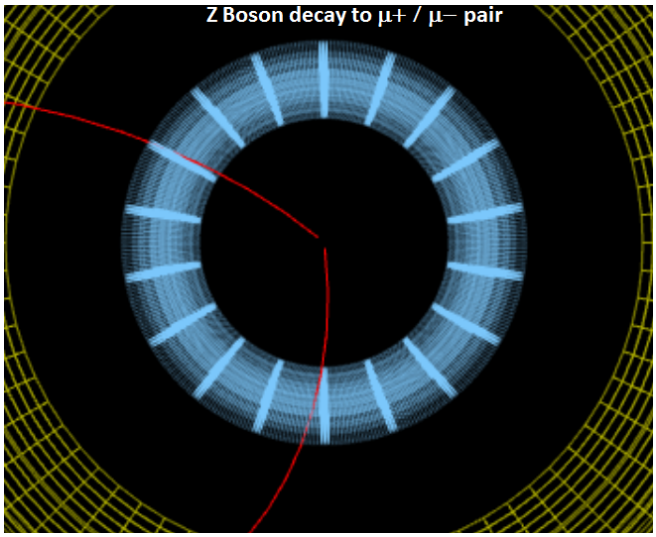

## What do you record?

- Indicate the final state by checking either **electron or muon**
- Indicate the primary particle by choosing **W+** if the lepton was positive (curved clockwise), **W-** if the lepton was negative (curved counter clockwise) or **W** if you cannot tell
- **Click Submit**

## Neutral Particle (Z Bosons)

- **Z Bosons** decay into **two leptons** (an electron / positron pair, **or** a $\mu+$ / $\mu-$ pair)



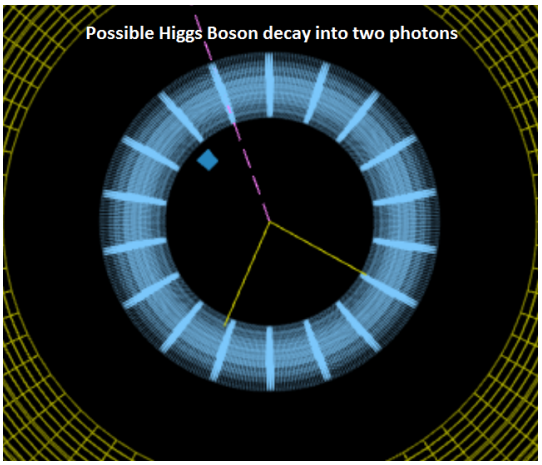



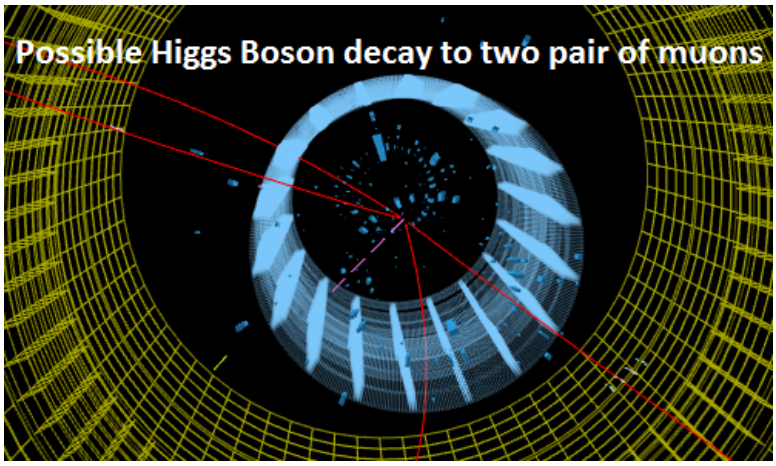

What do you record?

- **Click on 1st track then 2nd track and press the "m" key. Copy mass value into CIMA**
- Indicate the final state by checking either electron or muon.
- Indicate the primary particle by choosing NP (neutral particle). Click submit

## Neutral Particle (Higgs Bosons Candidates)

- **Higgs-like particles** will decay into **two Z particles** (so two pairs of leptons) or **two photons**
- **Photon tracks**(yellow lines) will appear inside the ECAL.




What do you record?

- **Click on the lepton or photon tracks and press the "m" key. Copy mass value into CIMA**
- Indicate the final state by checking either 4 electrons, 4 muons, or 2 electrons 2 muons.
- Choose Neutral Particle (NP). Click submit

## None of the Above:

- If the event does not match one of the categories above, then look at the **energy of the tracks (click once)**. If the energy is low 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.