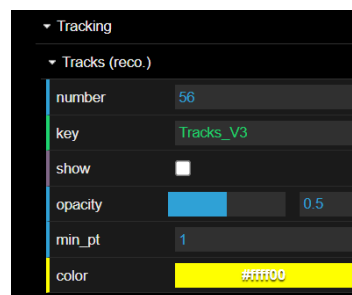
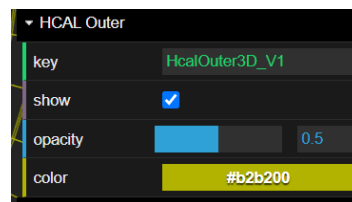


## Set-up

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 **iSpy** event analysis website at <https://www.i2u2.org/elab/cms/ispay-webgl/>
- Click the “open file” tab and choose “open files from the web”. Click on the file set assigned to you and your partner (N\*\*/). On the left, select the run files assigned to you and your partner(masterclass\_\*.ig), then select event 1 on the right and click “load”
- On the right side of the display, open the **Detector** controls. Scroll down to **HCAL Outer** and click to open. **Check the “show” box**. Open **Tracking** then **Tracks** and **uncheck the “show” box**.

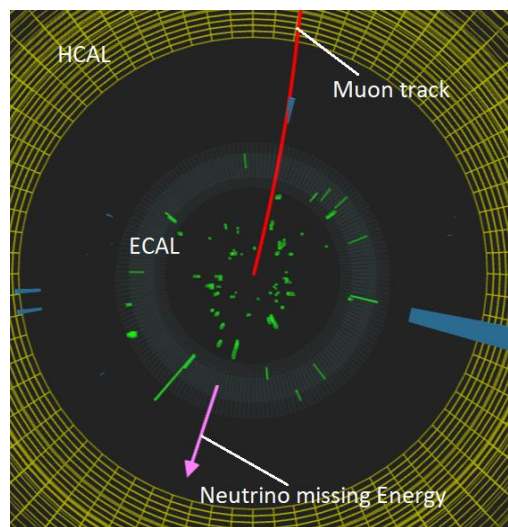
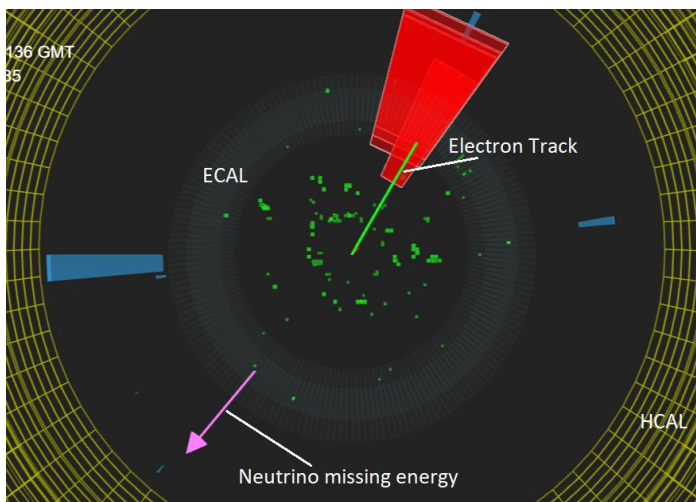


## Analysis

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

### 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**

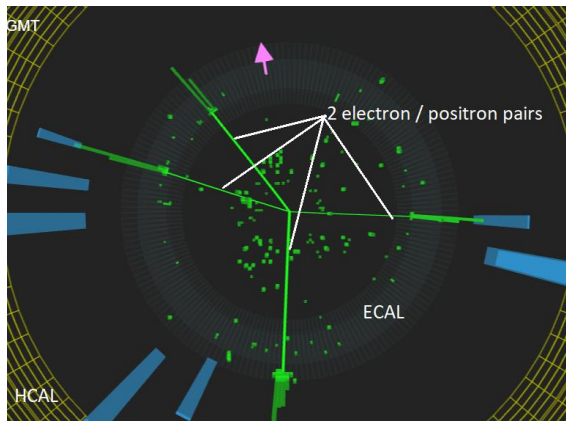
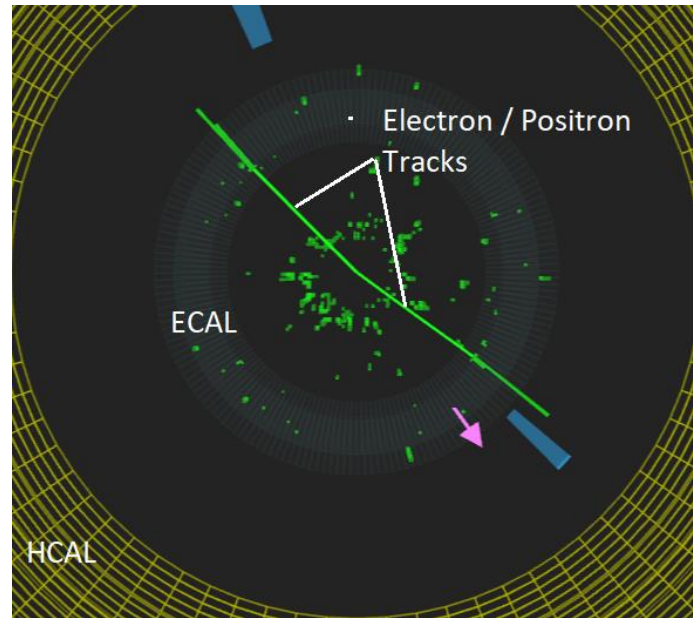
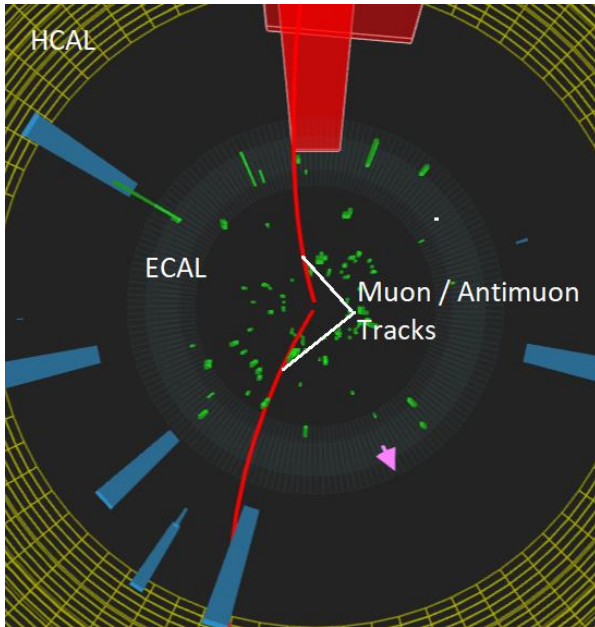


### What do you record in CIMA?

- **Final State:** electron + neutrino or muon + neutrino
- **Primary State:** W+ if the lepton was positive (curved cw), W- if the lepton was negative (curved ccw) or W+/- if you cannot tell

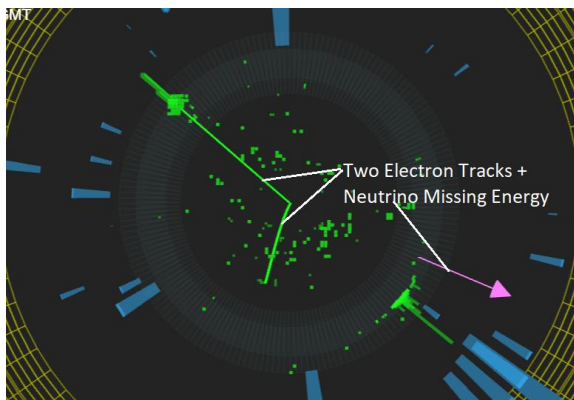
## Neutral Particle (Z, & Higgs Bosons)

- **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)
- Determine the mass of the neutral particle by **clicking on each track so they turn gray, then press the “m” key on the keyboard.**



What do you record in CIMA?

- **Final State:** electron / positron pair; muon / antimuon pair; 2 electron / positron pairs; 2 muon / antimuon pairs; 1 electron / positron pair + 1 muon / antimuon pair
- **Primary State:** Neutral Particle (Z, Higgs)
- **Mass:** Mass of the neutral particle



**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.