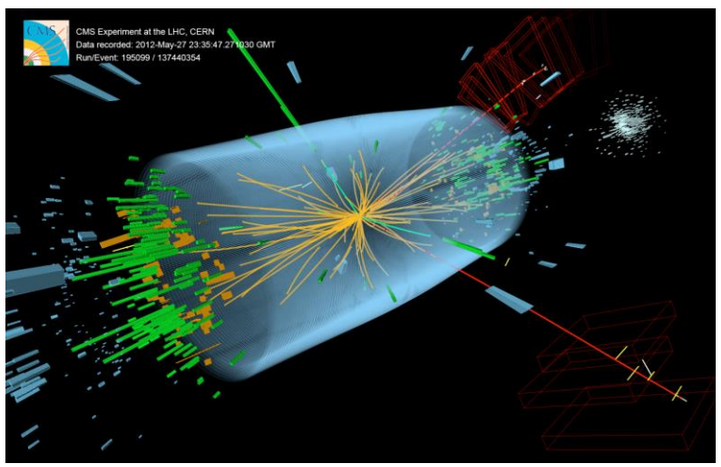
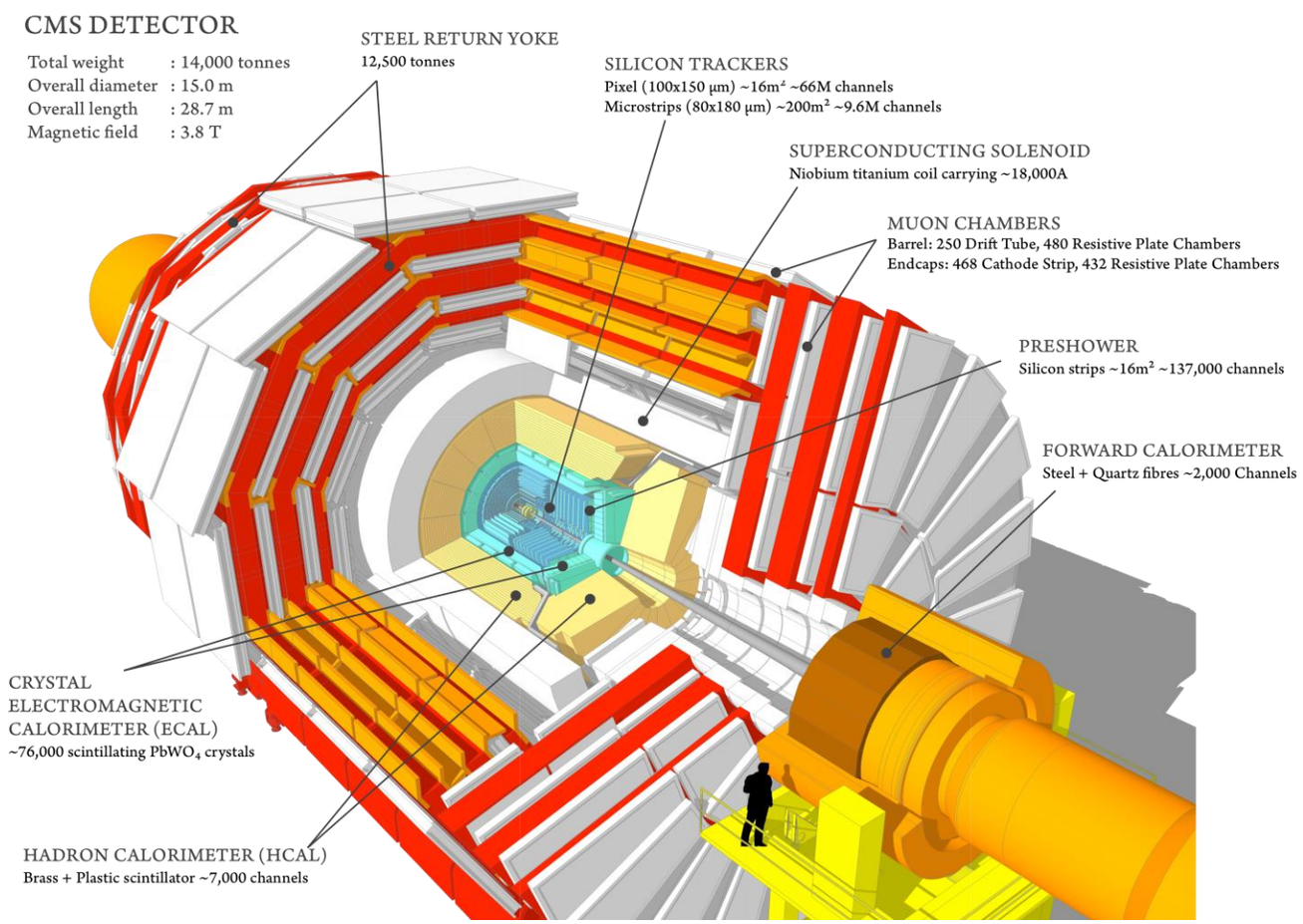
CMS Masterclass 2018 for Moderators





CMS masterclass features

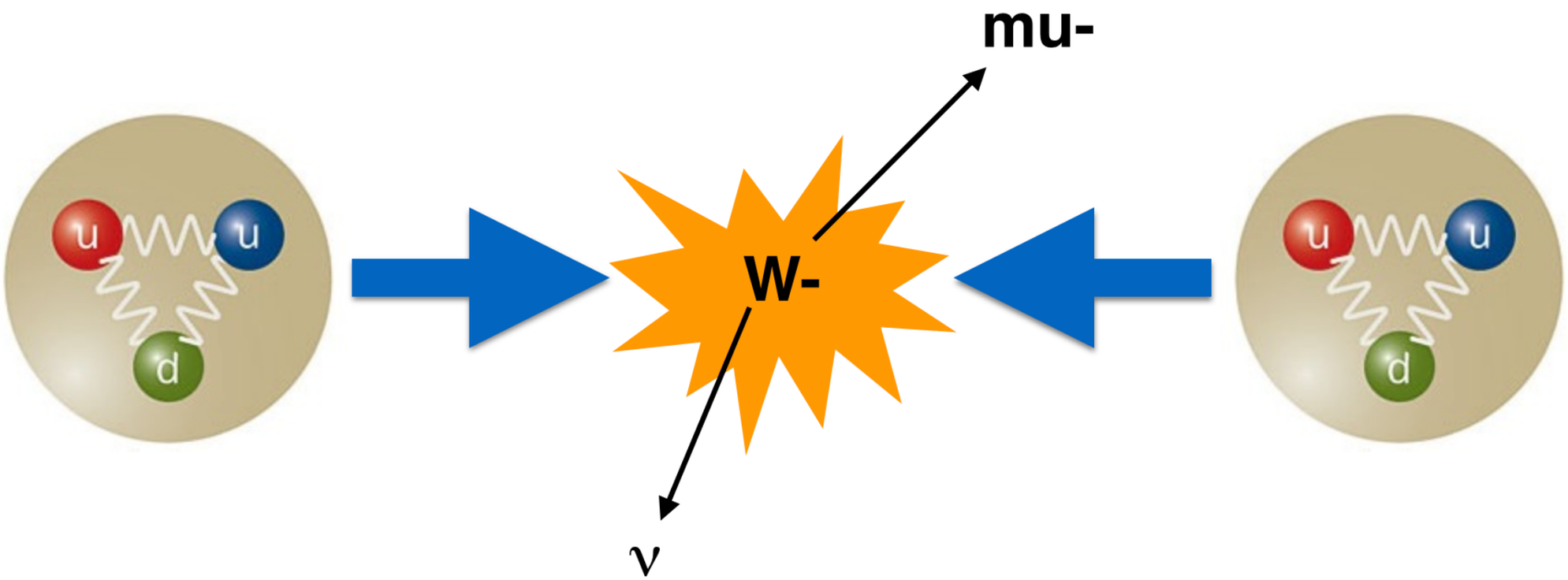
- *10 000 events (divided into 100 datasets):*
  - *W*
  - *Z, J/Psi, Upsilon*
  - *H→* 2 photons*, few, repeated*
  - *H→ ZZ, few, repeated*

- *Event display: iSpy-WebGL*
- *CIMA – CMS Instrument for Masterclass Analysis*
- *Updated documentation at http://tiny.cc/cms-doc-imc18.*

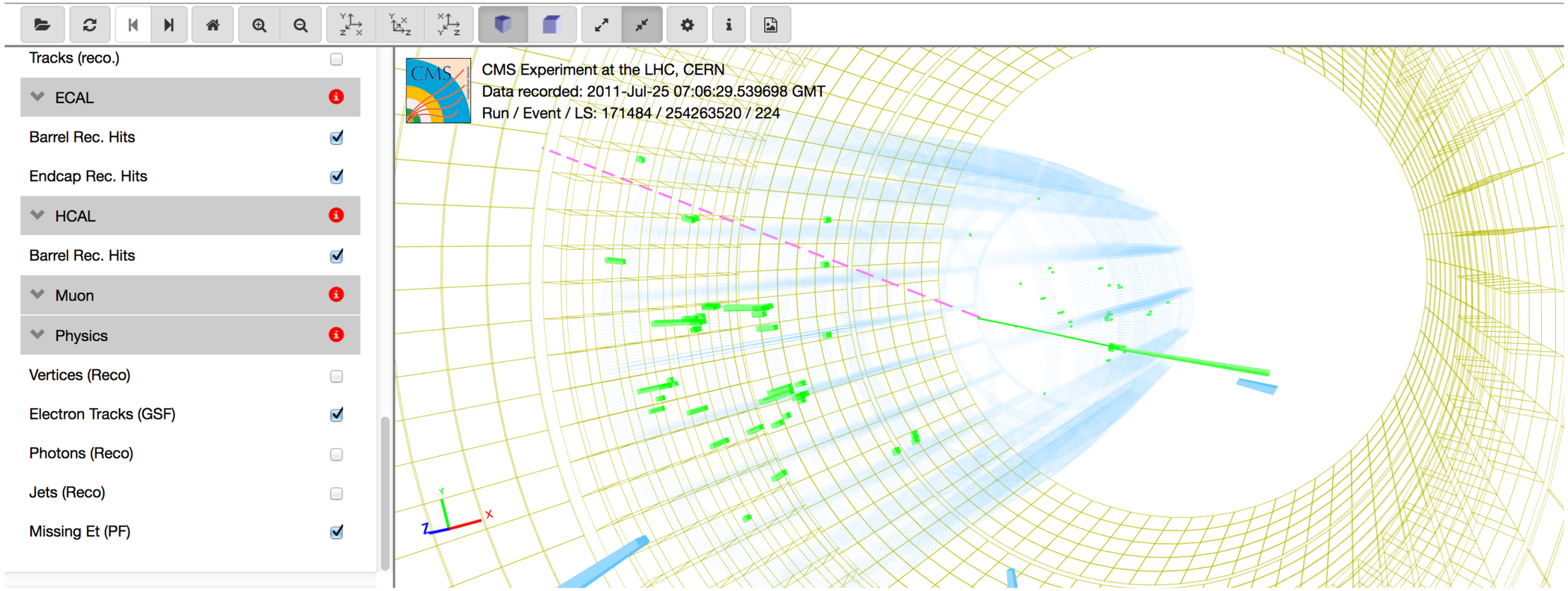
Students find e:mu and W+:W-; create dilepton mass plot.

About collisions

- Protons as “bags of partons”
- Parton-parton collisions
- Each parton shares only a portion of proton momentum
- W+:W- as probe of proton structure



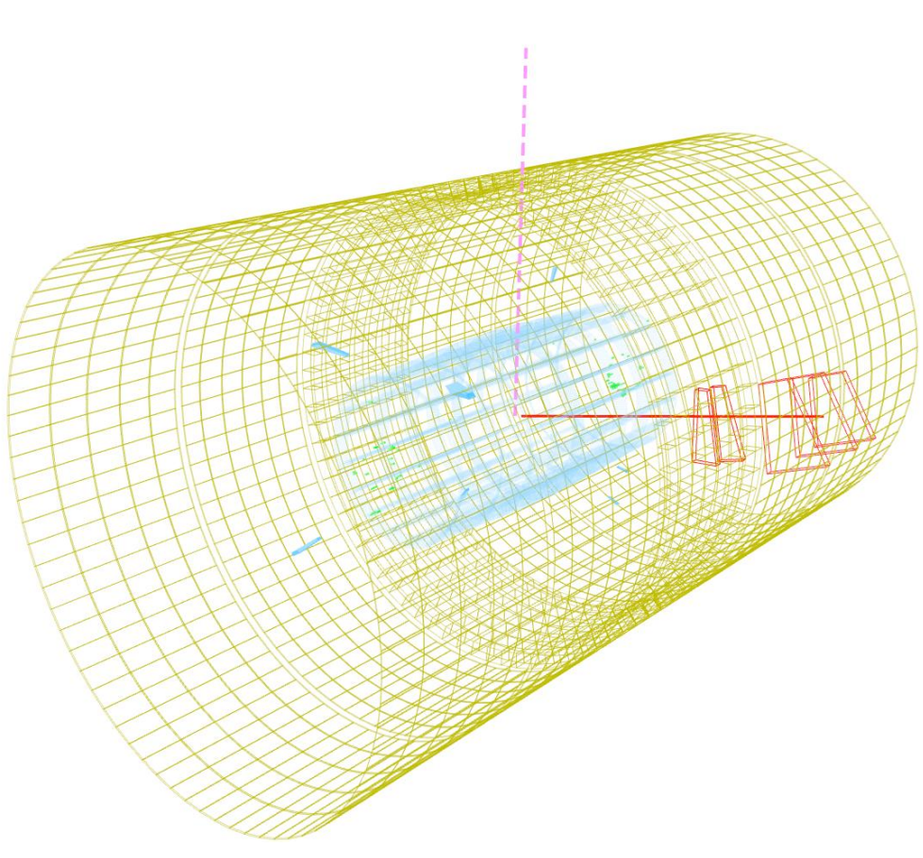
iSpy-WebGL

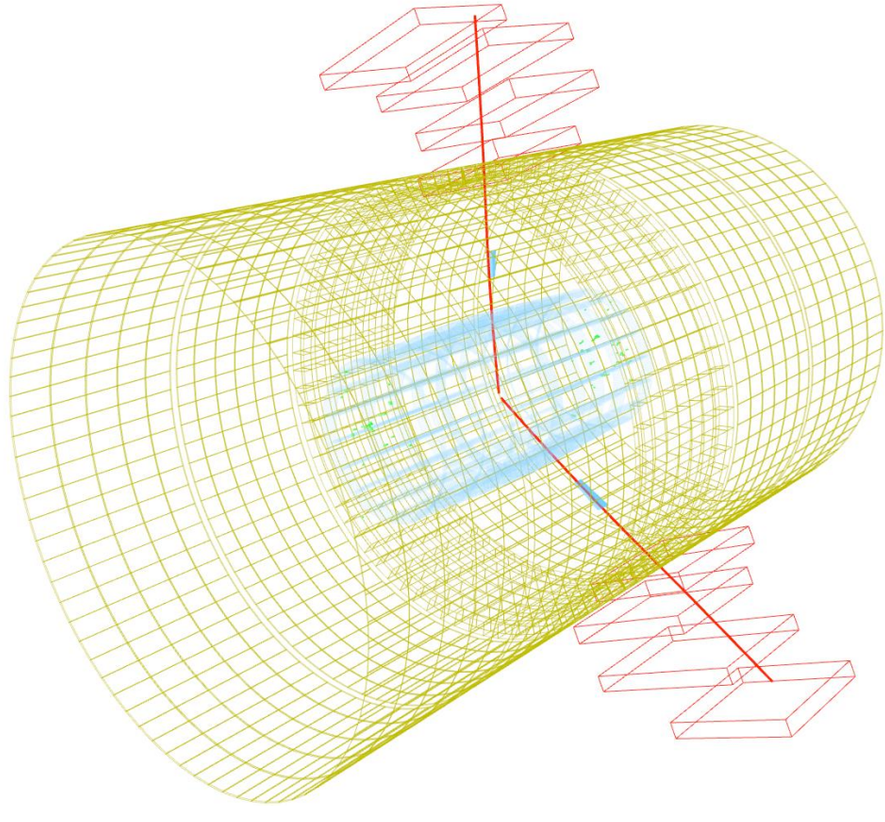

Tracks (reco.)
ECAL
Barrel Rec. Hits
Endcap Rec. Hits
HCAL
Barrel Rec. Hits
Muon
Physics
Vertices (Reco)
Electron Tracks (GSF)
Photons (Reco)
Jets (Reco)
Missing Et (PF)
CMS
CMS Experiment at the LHC, CERN
Data recorded: 2011-Jul-25 07:06:29.539698 GMT
Run / Event / LS: 171484 / 254263520 / 224
Y
X
Z

Student tasks

Students must distinguish W from Z candidates.

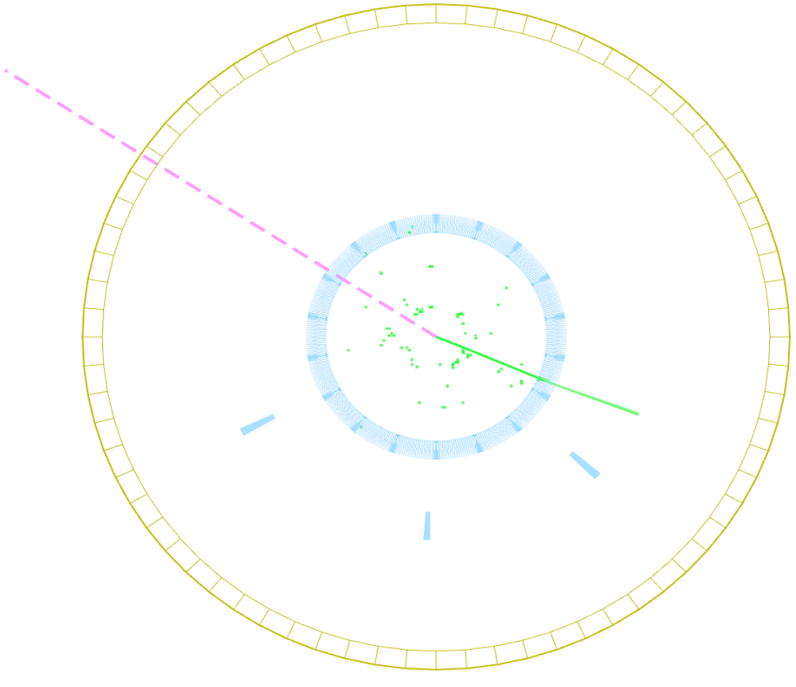
Typical questions are about 2nd or 3rd lepton track (check pt)

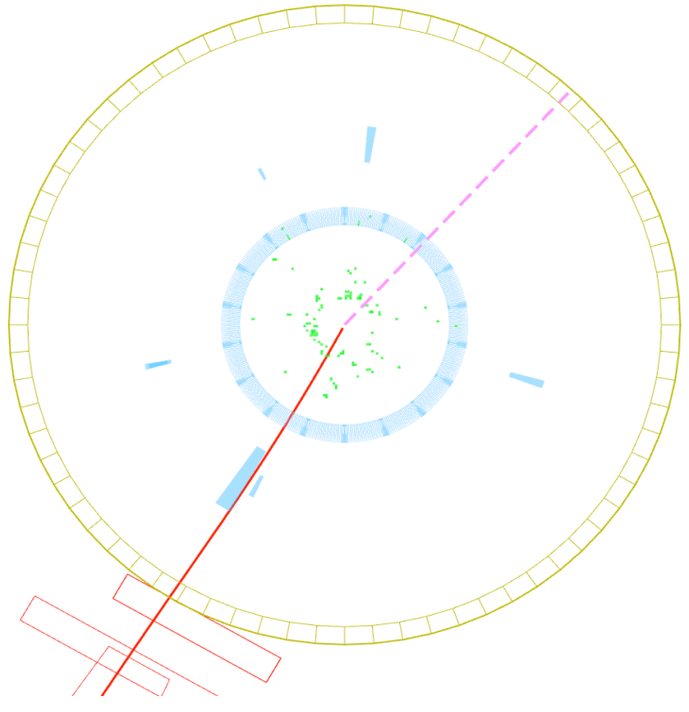




Student tasks

Students distinguish electron *events* from muon *events*.

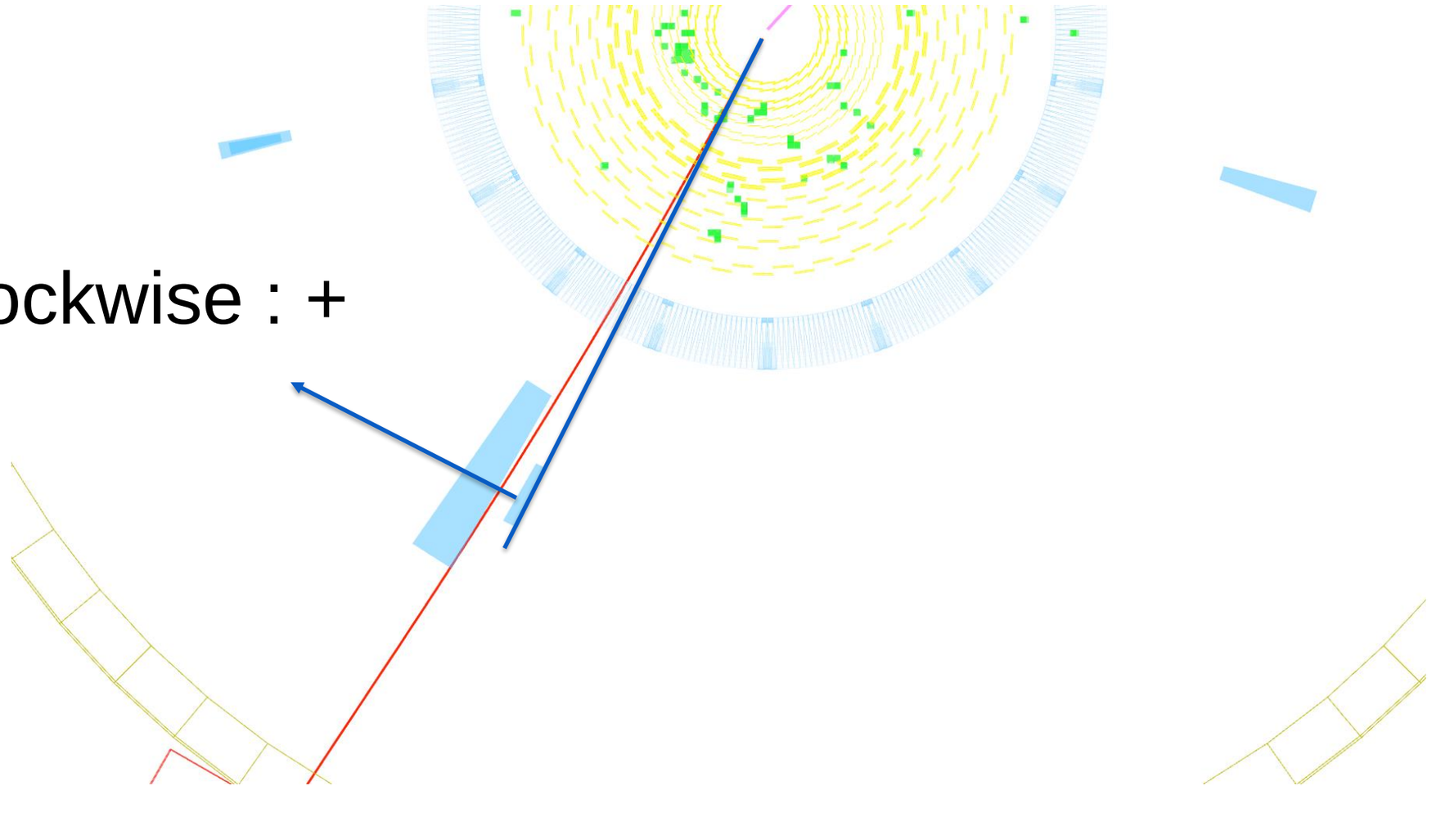




Student Tasks

Students distinguish W+ from W- using track curvature.

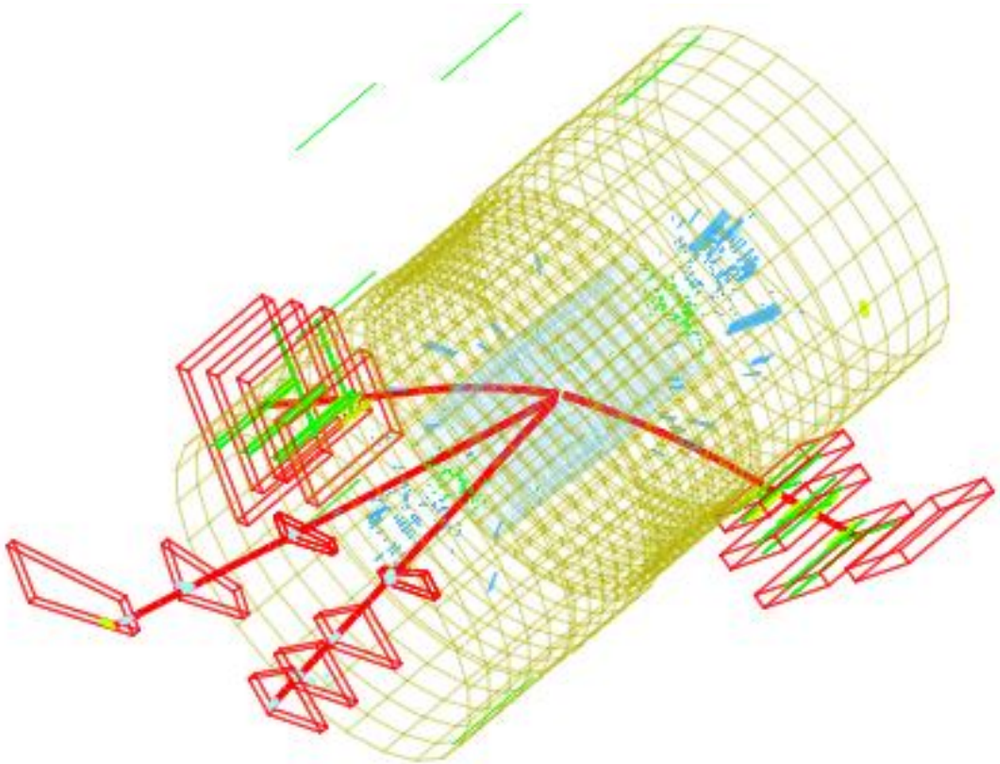
Clockwise : +

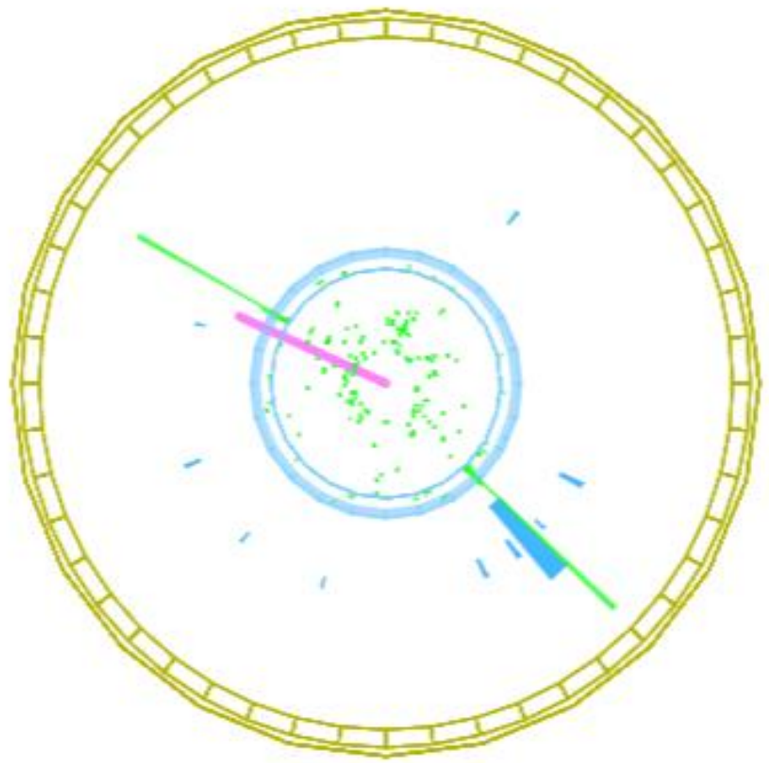


Student tasks

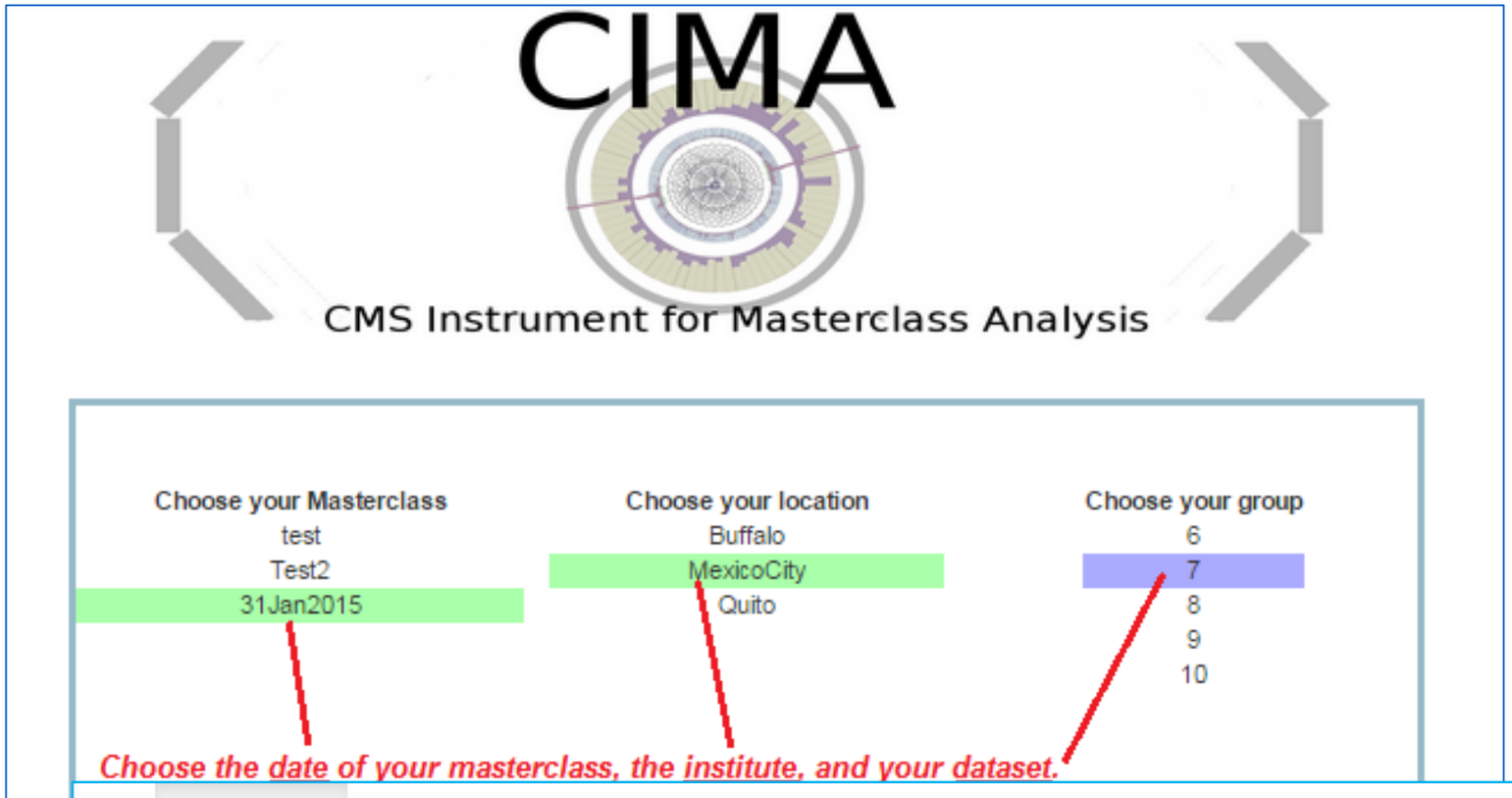
Students look for H→ZZ and H→diphoton events.

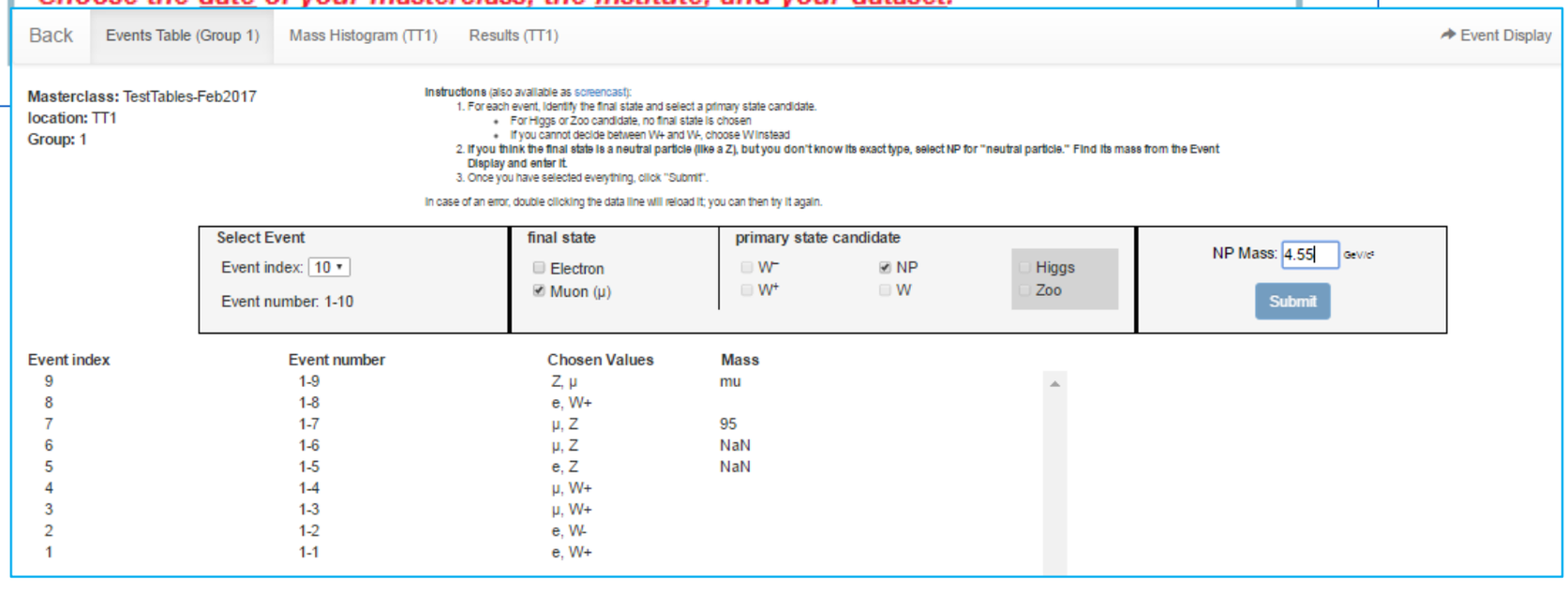
Occasionally, students "find" too many Higgs candidates.





Recording event data

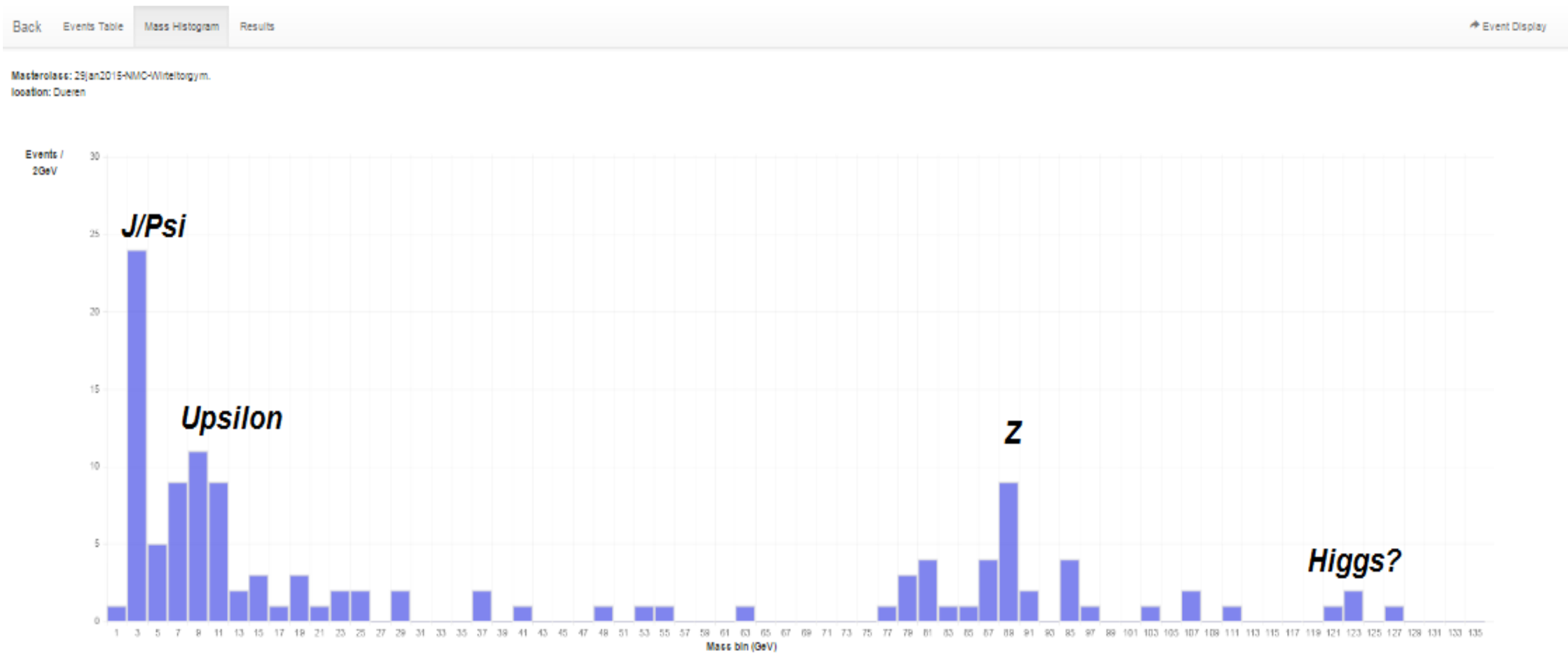




Find your dataset.

Record parent particles and decay modes.

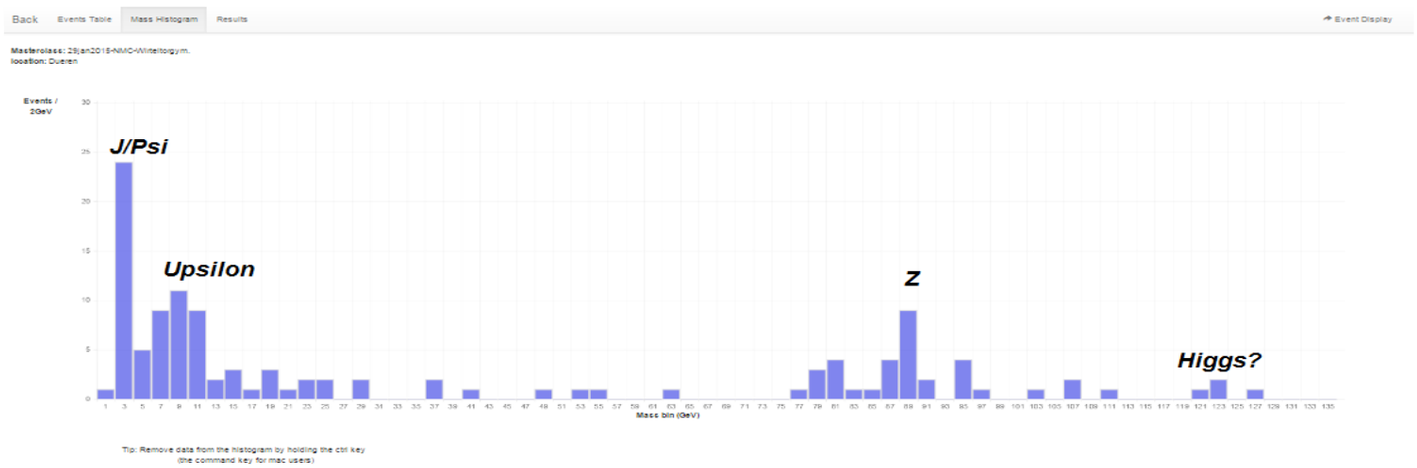
What you see


Back
Events Table
Mass Histogram
Results
Event Display
Masterclass: 29jan2015-NMC-Wirteltorgym.
location: Dueren
Events / 2GeV
J/Psi
Upsilon
Z
Higgs?
Mass bin (GeV)
Tip: Remove data from the histogram by holding the ctrl key
(the command key for mac users)

Questions you can ask

Ask the students:

- Where are the peaks in the Mass Histogram? What do they represent?
- Where is Z boson in the plot? What are the other peaks, then?
- Do you have possible Higgs events in the plot? Where? Can we claim discovery?



What you see

Back | Events Table | Mass Histogram | Results

Masterclass: 29jan2015-NIKHAFWiteltorgym.
location: Dueren

Group	Muon	Electron	W	W-	W+	Z	Higgs	Zoo	Total
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	19	22	6	6	10	19	0	18	59
4	23	15	0	9	16	13	1	13	52
5	18	21	10	9	9	11	0	8	47
6	8	8	1	6	4	5	0	11	27
7	0	0	0	0	0	0	0	0	0
8	16	15	2	7	10	12	1	14	46
9	21	13	2	11	10	11	0	14	48
10	0	0	0	0	0	0	0	0	0
11	26	24	0	14	19	17	0	1	51
12	15	19	0	7	13	14	3	10	47
13	15	22	0	11	16	10	1	6	44
14	24	15	0	7	17	15	0	8	47
15	0	0	0	0	0	0	0	0	0

Total:

Muon	Electron	W	W-	W+	Z	Higgs	Zoo	Sum	e/mu	W+/W-
185	174	21	87	124	127	6	103	468	0.94	1.43

Questions you can ask

Ask the students:

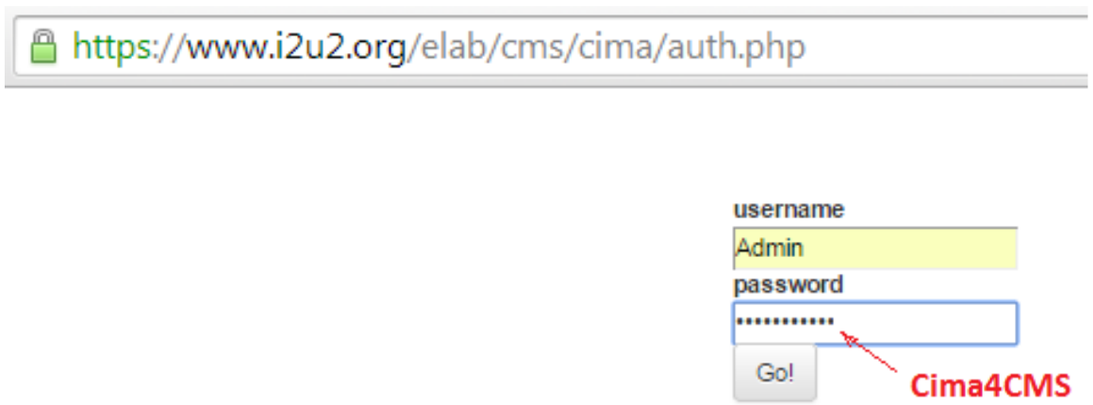
- What do you expect the ratio of electron events to muon events to be? Is your result consistent with this?
- What is the ratio of W+ to W- bosons? What does this ratio tell us about protons?

14	24	15		0	7	17	15	0	8	47
15	0	0		0	0	0	0	0	0	0

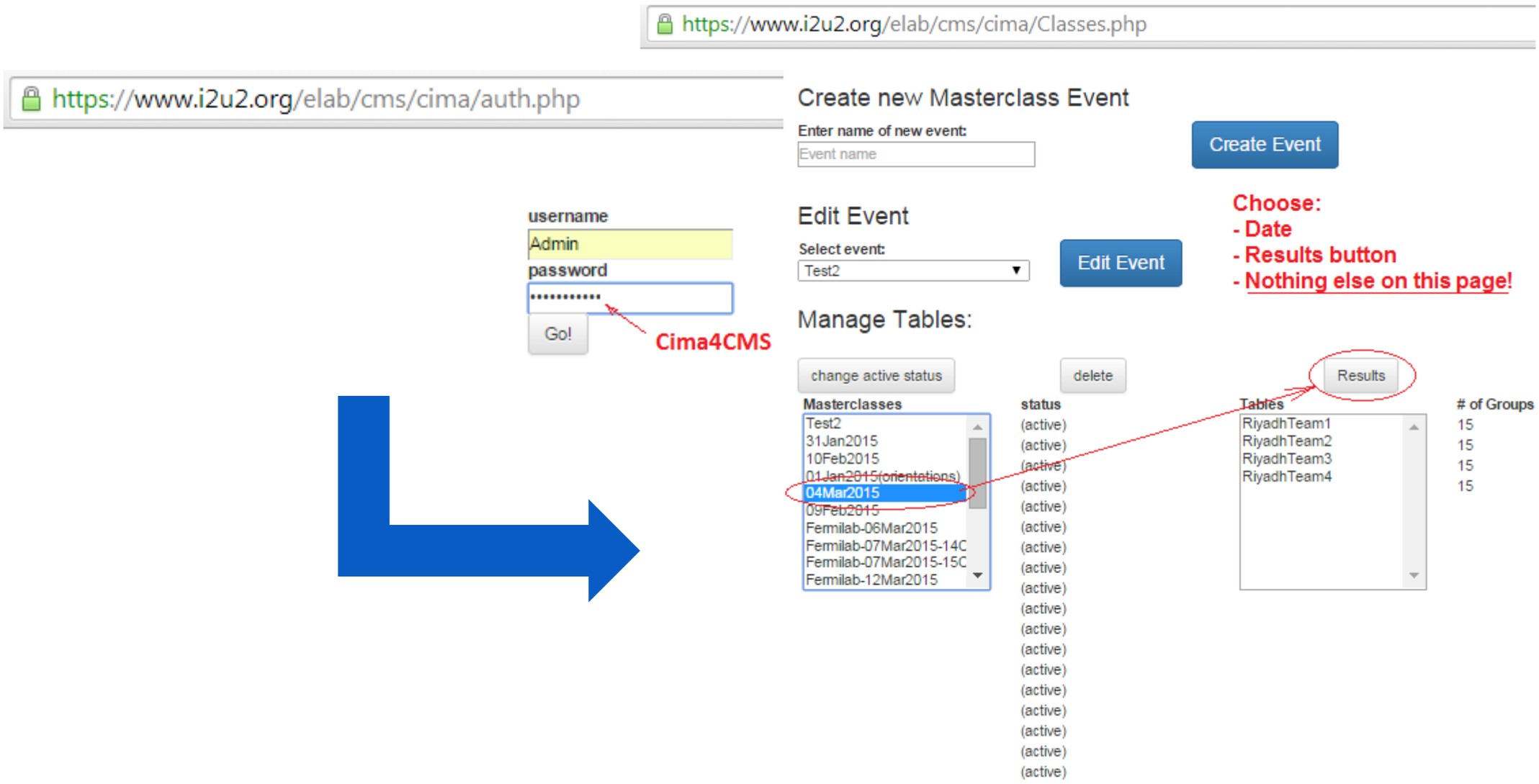
Total:

Muon	Electron	W	W-	W+	Z	Higgs	Zoo	Sum	e/mu	W+/W-
185	174	21	87	124	127	6	103	468	0.94	1.43

Additional step with CIMA



Additional step with CIMA



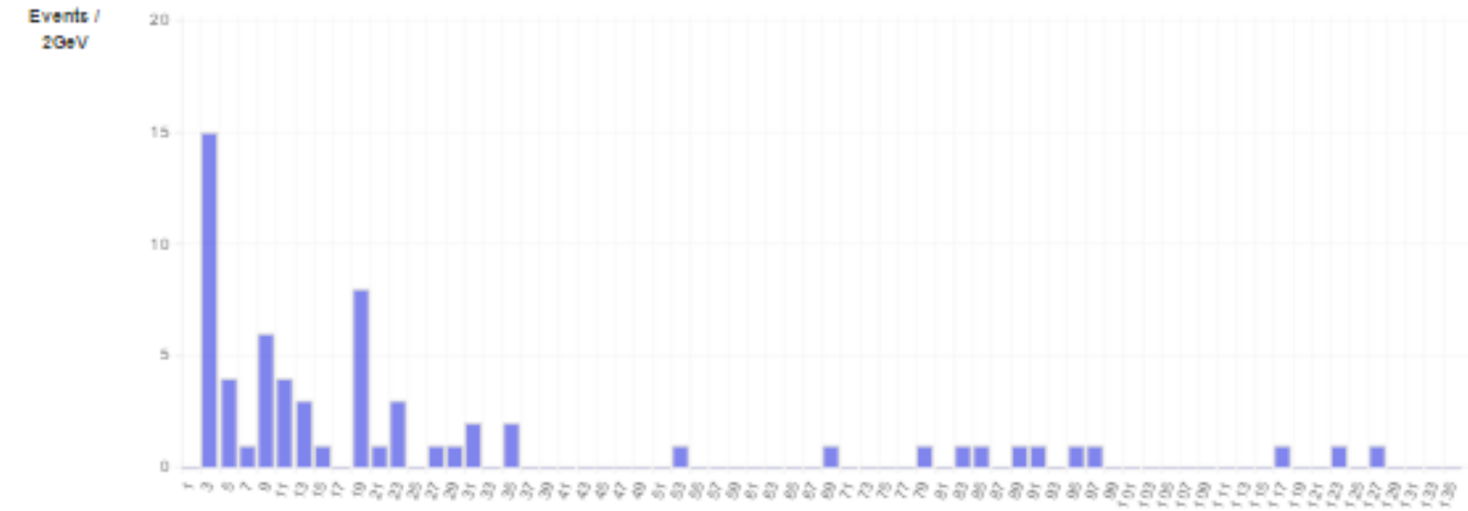
Combined results

Tables: RiyadhTeam1 RiyadhTeam2 RiyadhTeam3 RiyadhTeam4

Group	Muon	Electron	W	W-	W+	Z	Higgs	Zoo	Total
1	0	1	0	1	0	0	1	0	2

Back | Mass Histogram | Results

Tables: RiyadhTeam1 RiyadhTeam2 RiyadhTeam3 RiyadhTeam4



						6	1	0	17
						1	0	0	1
						20	0	3	50
						0	0	0	0
						0	0	0	0
						2	0	0	2
						0	0	0	0
						0	0	0	0
						0	0	0	0
						0	0	0	0
						0	0	0	0
						0	0	0	0
						0	0	1	1
						0	0	0	0
						0	0	0	0
						9	1	2	29
						1	0	0	5
						0	0	0	0
						0	0	0	0
						4	0	0	22
						0	0	0	0
27	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0
29	16	15	6	6	8	11	0	8	39
30	0	0	0	0	0	0	0	0	0

Total:

Muon	Electron	W	W-	W+	Z	Higgs	Zoo	Sum	e/mu	W+/W-
78	73	9	46	42	54	3	14	168	0.94	0.91

Q&A

Students might ask:

- *About individual events →try to keep it general*
- *About double events, like W+W- or WZ (nope)*
- *Life at CERN or Fermilab*
- *Popular doomsdays*

You might ask or comment on:

- *How students decided on specific candidate events*
- *No. of events needed for “good” results*
- *How their day went*

Questions for Ken: kcecire@nd.edu