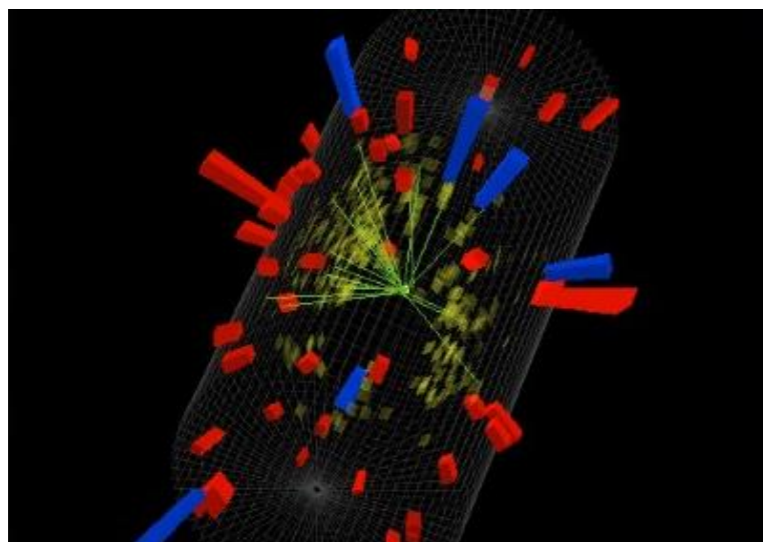
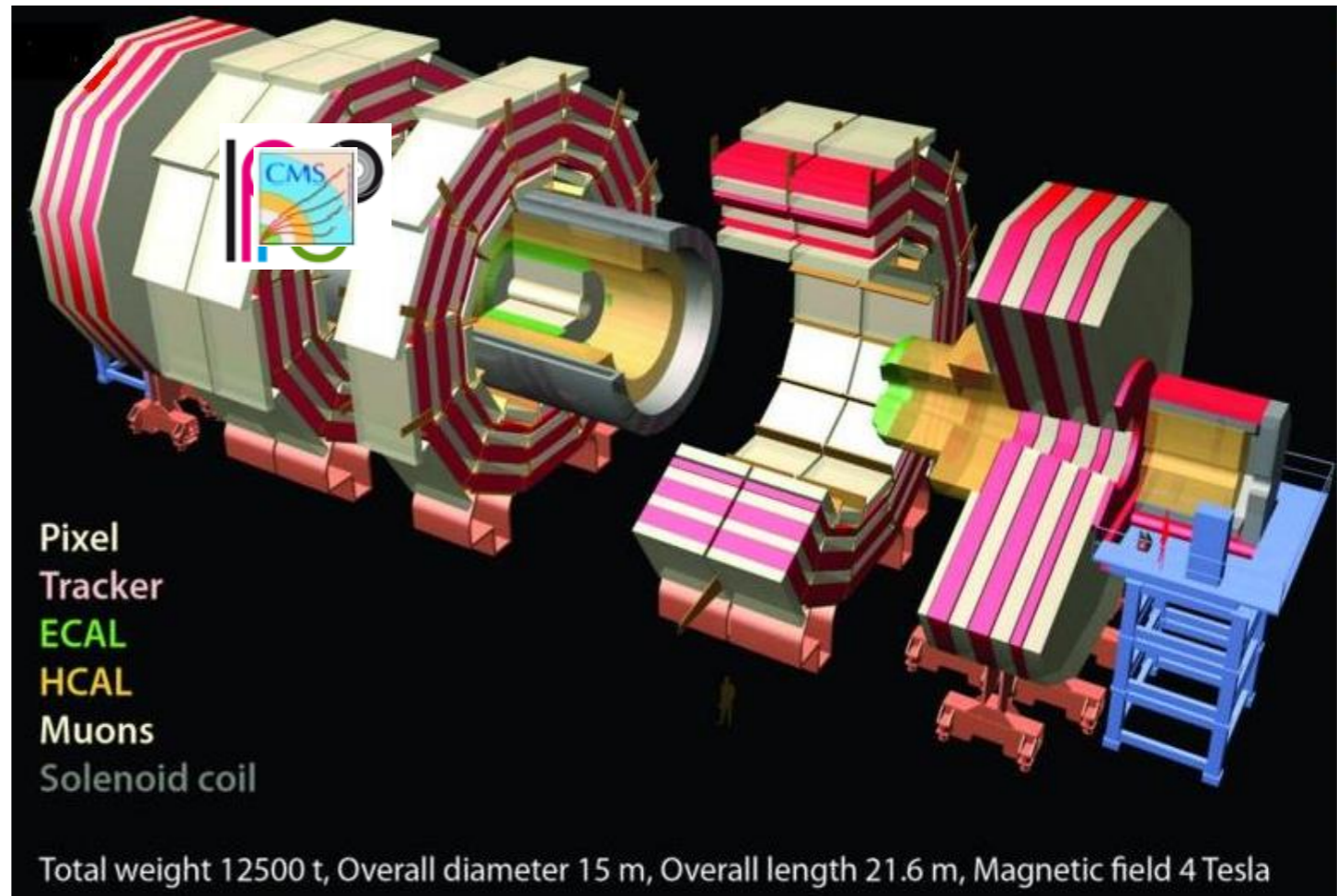


Helping Develop America's Technological Workforce



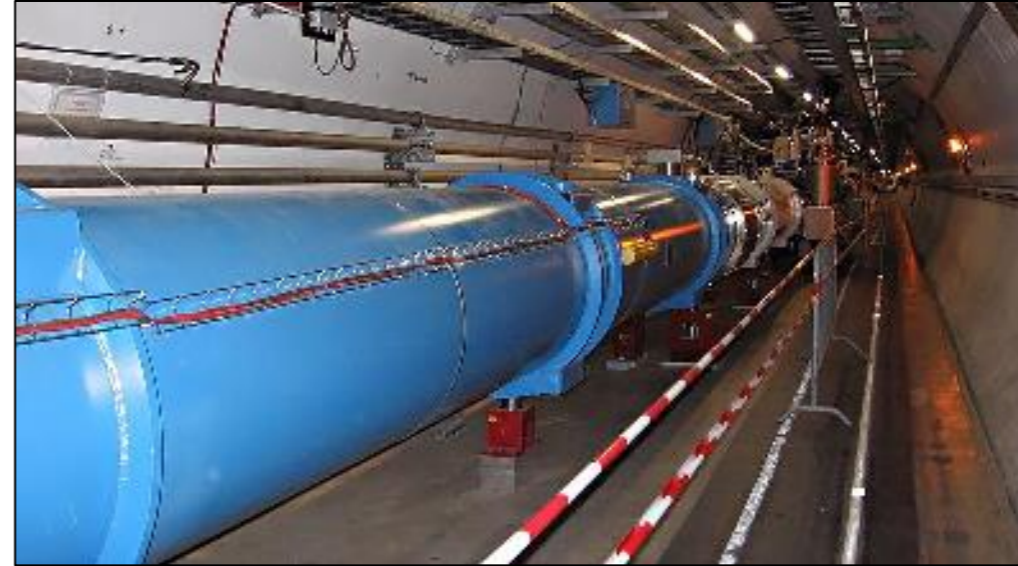
CMS Masterclass 2015 for Moderators





CMS masterclass features

- *3000 events:*
 - *W*
 - *Z, J/ψ, Y*
 - *10 $H \rightarrow \gamma\gamma$, repeated*
 - *3 $H \rightarrow ZZ$, repeated*
- *iSpy-online (WebGL version in testing)*
- **New!** *CIMA – CMS Instrument for Masterclass Analysis*
- *Updated documentation at*
<http://tinyurl.com/cmsmcdoc2015>.

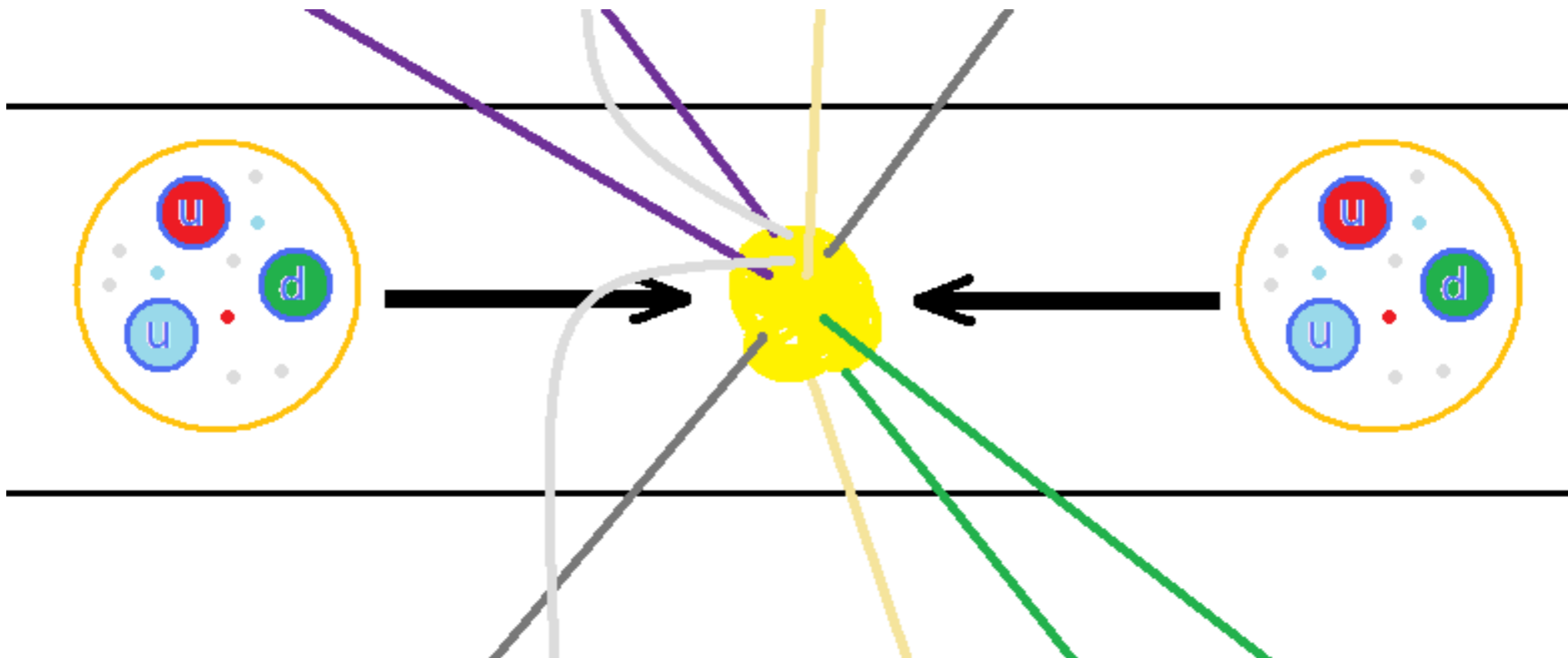


Students find e/μ and W^+/W^- ; create dilepton and Higgs mass plot.



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





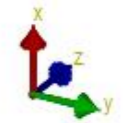
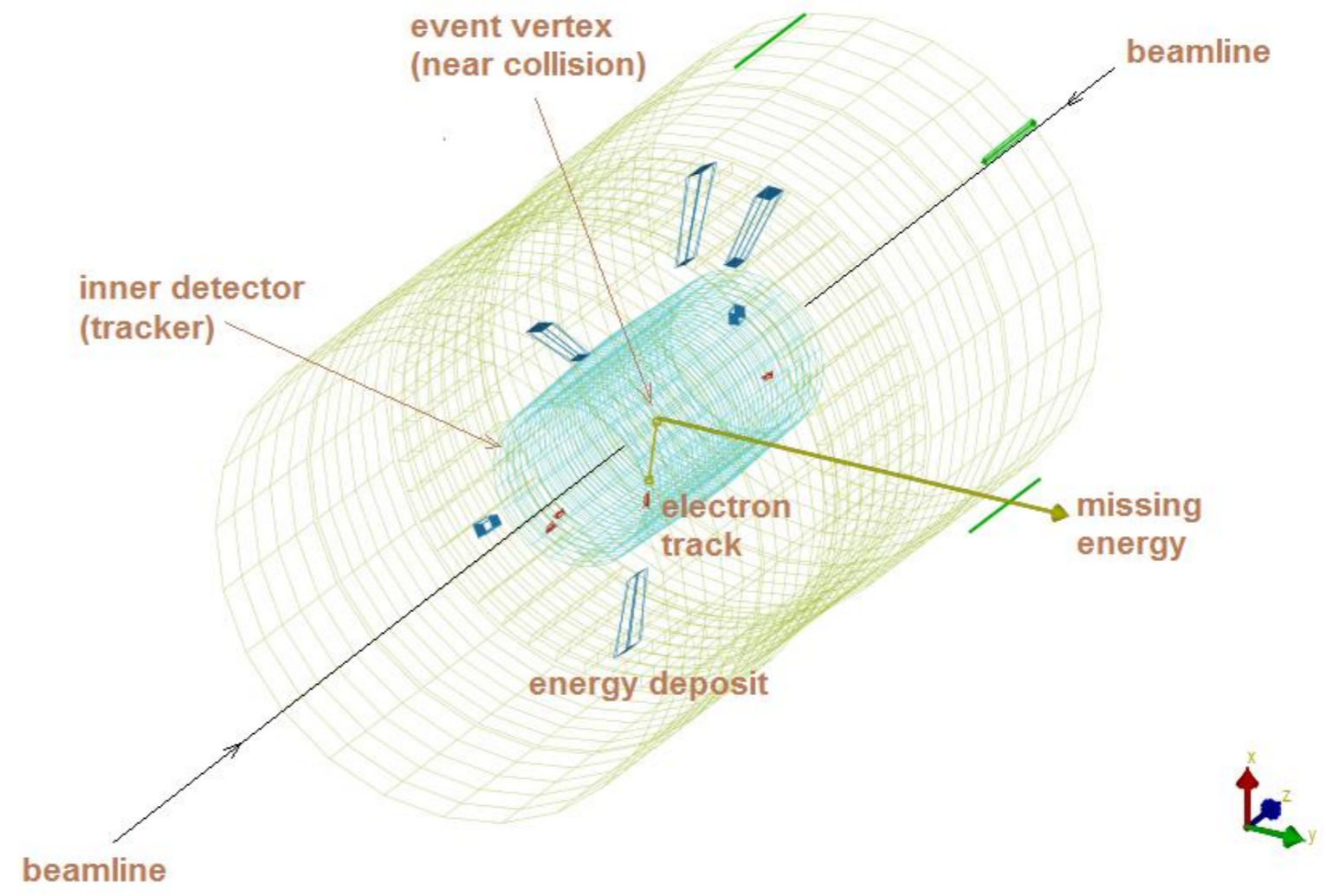
iSpy-online



- Detector Model** ?
- Tracker
 - ECAL Barrel
 - ECAL Endcap
 - ECAL Preshower
 - HCAL Barrel
 - HCAL Endcap
 - HCAL Outer
 - HCAL Forward
 - Drift Tubes (muon)
 - Cathode Strip Chambers (muon)
 - Resistive Plate Chambers (muon)
- Tracking** ?
- Tracks (reco.)
 - Clusters (Si Pixels)
 - Clusters (Si Strips)
 - Rec. Hits (Tracking)
- ECAL** ?
- Barrel Rec. Hits
 - Endcap Rec. Hits
 - Preshower Rec. Hits
- HCAL** ?
- Barrel Rec. Hits
 - Endcap Rec. Hits
 - Forward Rec. Hits
 - Outer Rec. Hits

- Controls:**
- rotate
 - Ctrl** + → pan x / y
 - Shift** + → pan z

event display controls

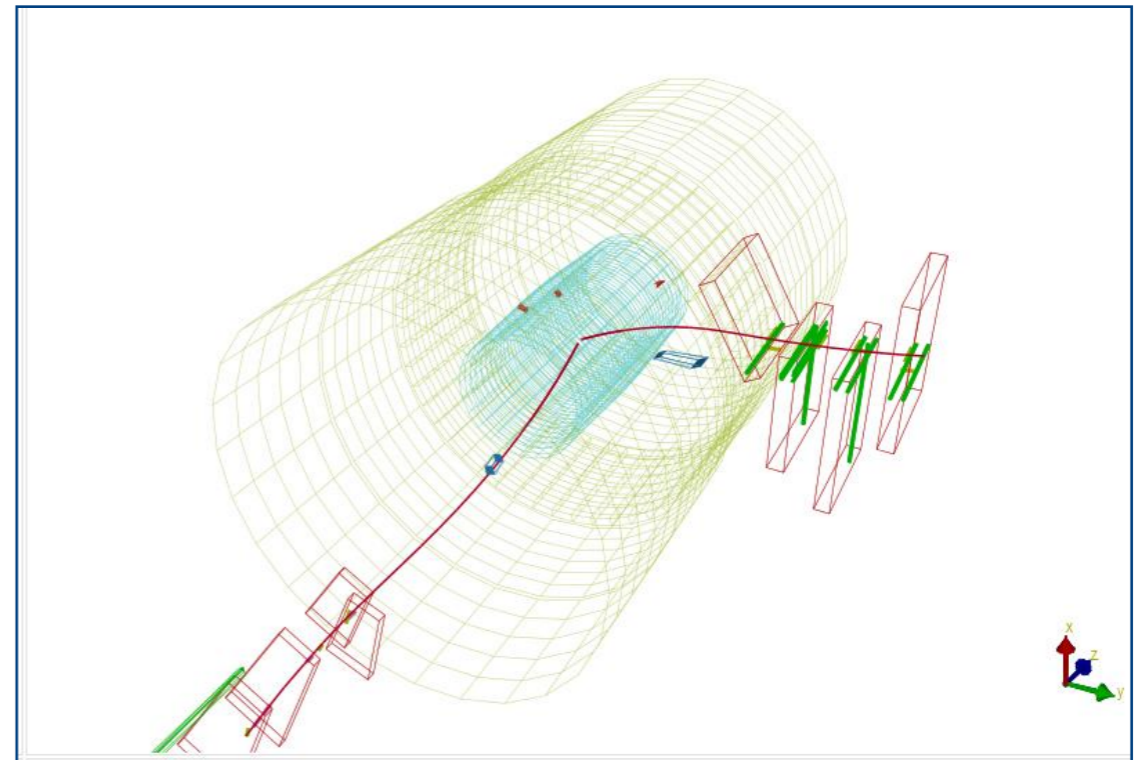
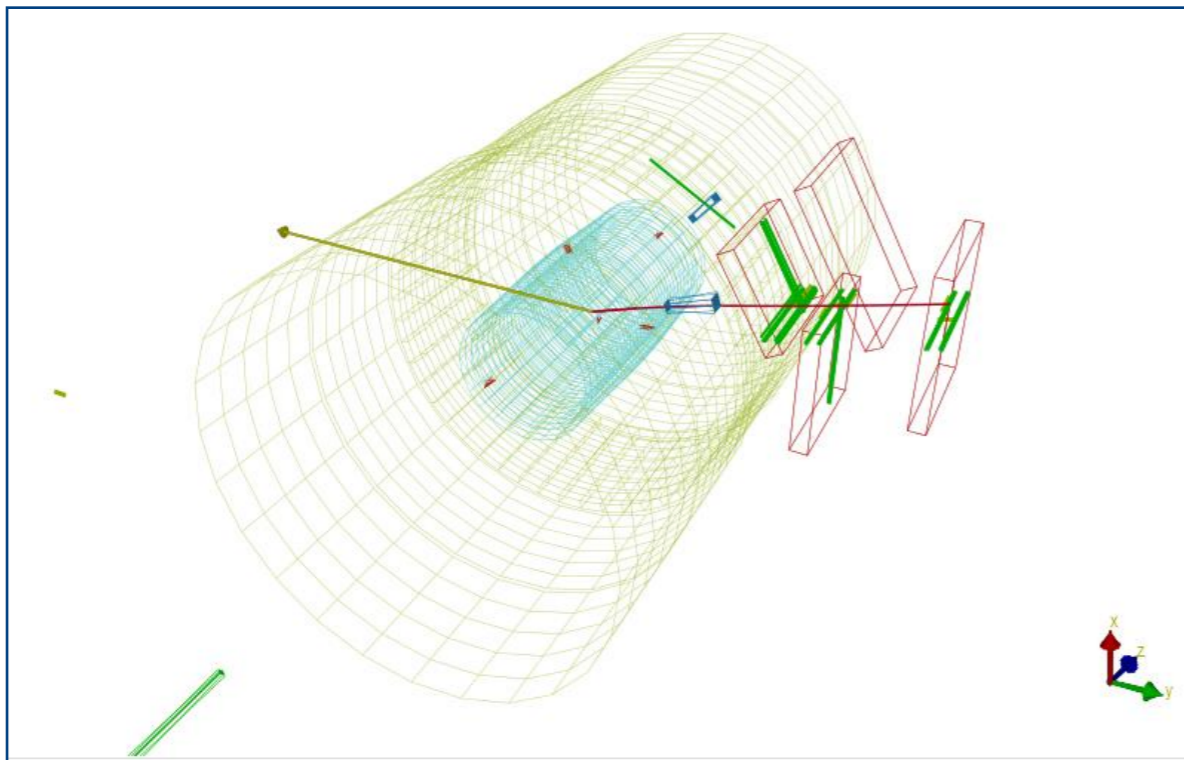




Student tasks

Students must distinguish W from Z candidates.

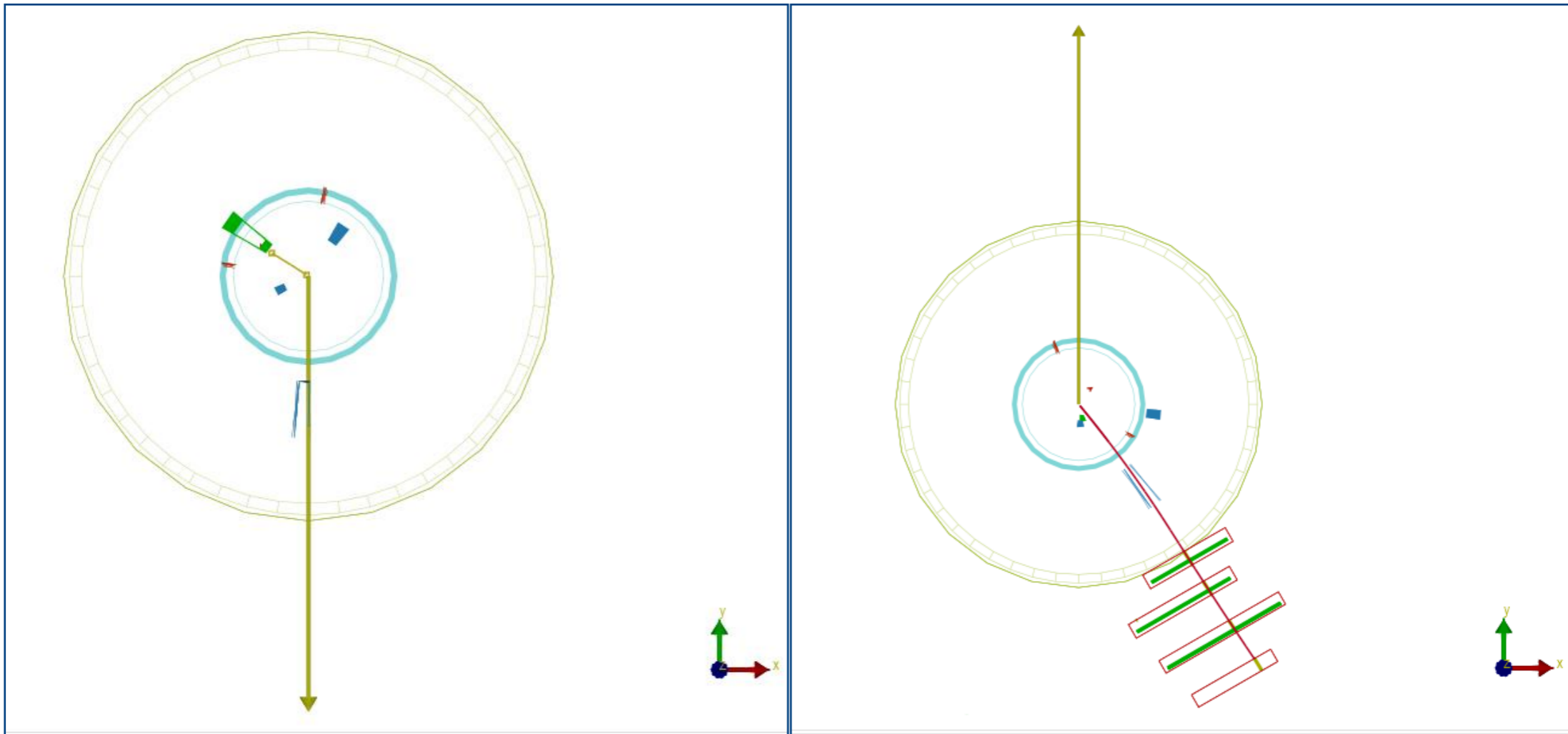
Typical questions are about third lepton track or high missing E_t in dilepton event.





Student tasks

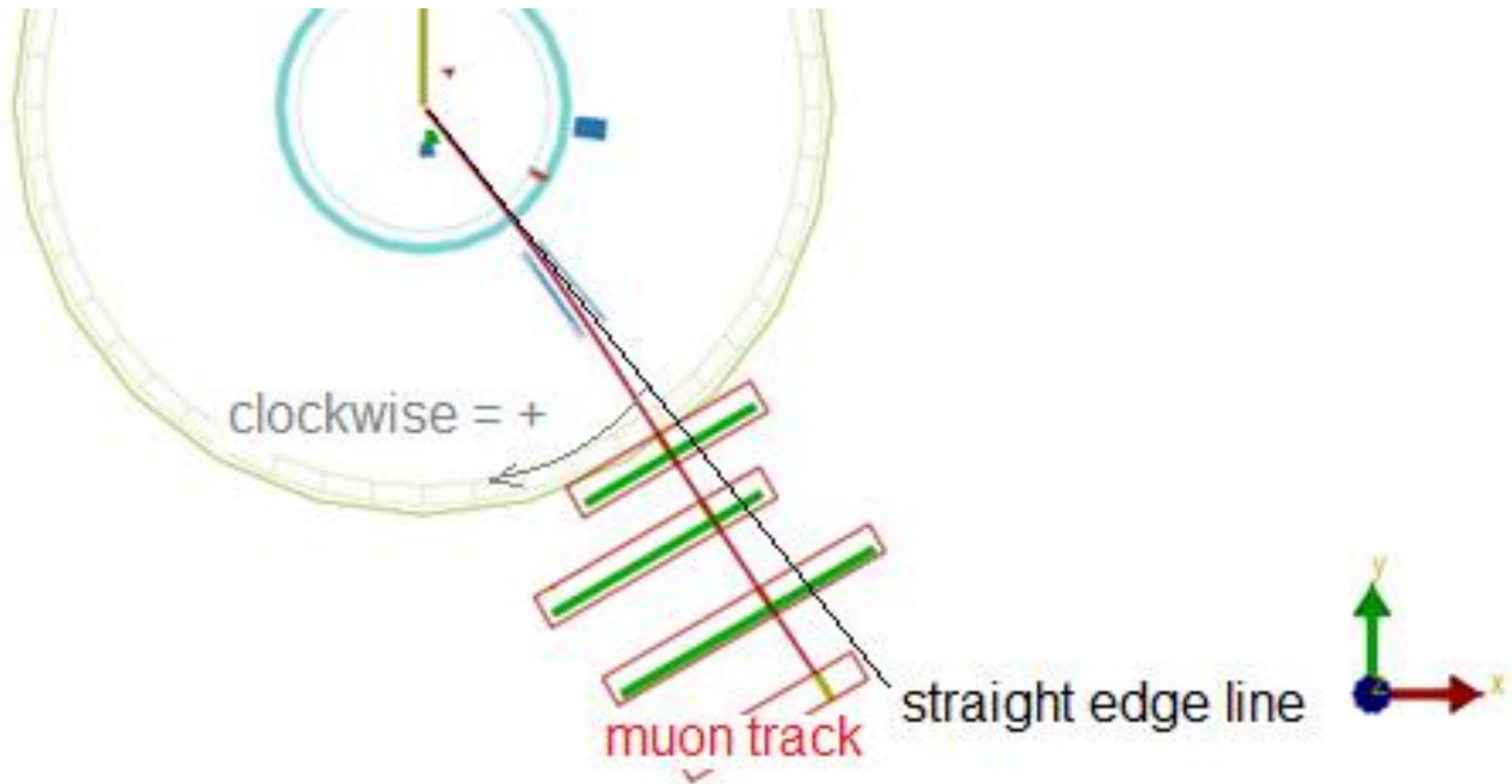
Students distinguish electron *events* from muon *events*.





Student Tasks

Students distinguish W^+ from W^- using track curvature.

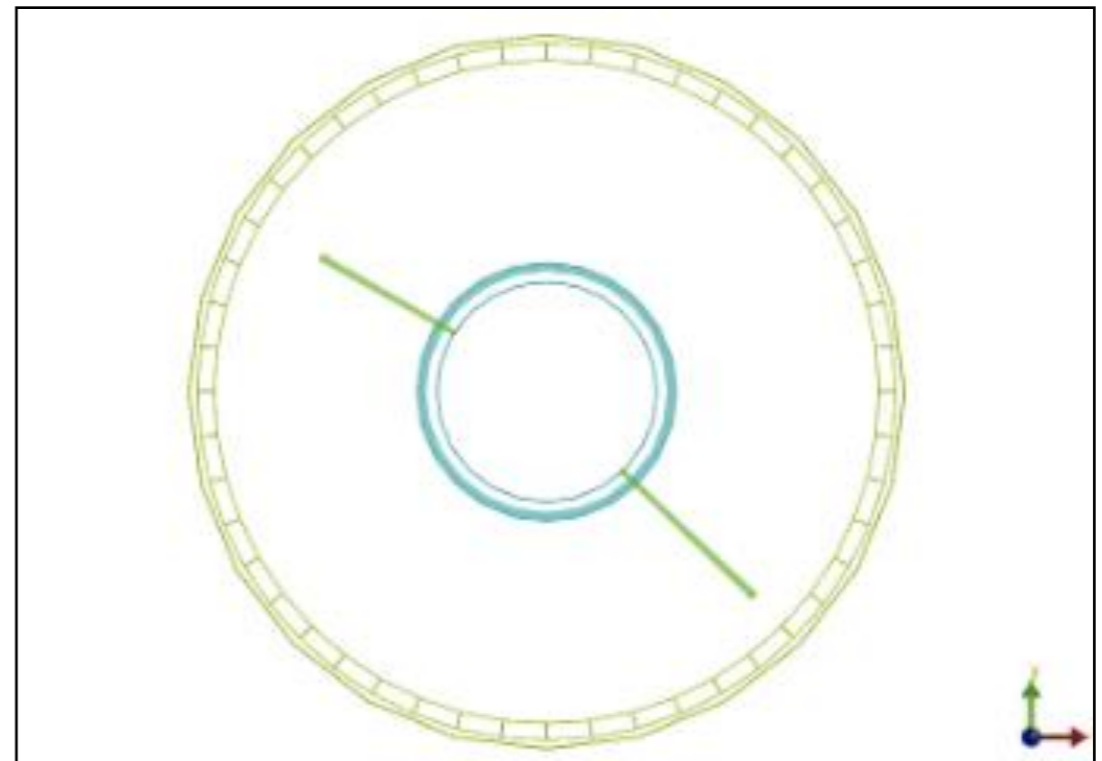
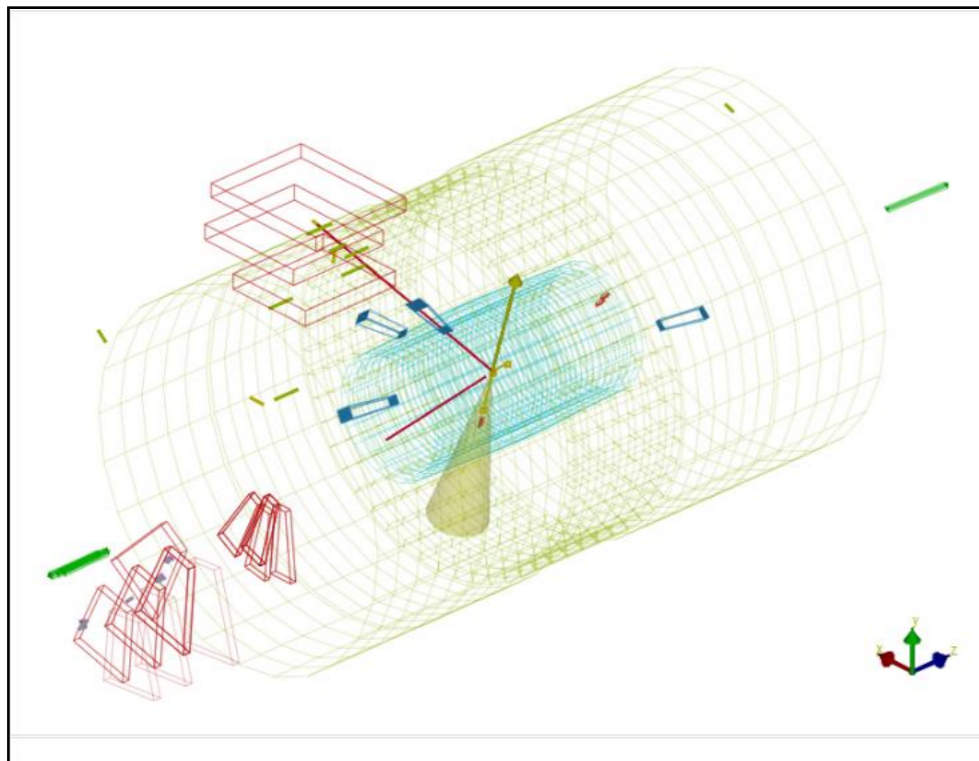




Student tasks

Students look for $H \rightarrow ZZ$ and $H \rightarrow \gamma\gamma$ events.

Occasionally, students “find” too many Higgs candidates.





Recording event data



Find your dataset.

Record parent particles and decay modes.

Choose your Masterclass
test
Test2
31Jan2015

Choose your location
Buffalo
MexicoCity
Quito

Choose your group
6
7
8
9
10

Choose the date of your masterclass, the institute, and your dataset.

Back Events Table Mass Histogram Results

Masterclass: 31Jan2015
location: MexicoCity
Group: 8

Event index: 705 Event number: 27431673

final state
 Electron
 Muon

primary
 Higgs
 W

Z
 W+

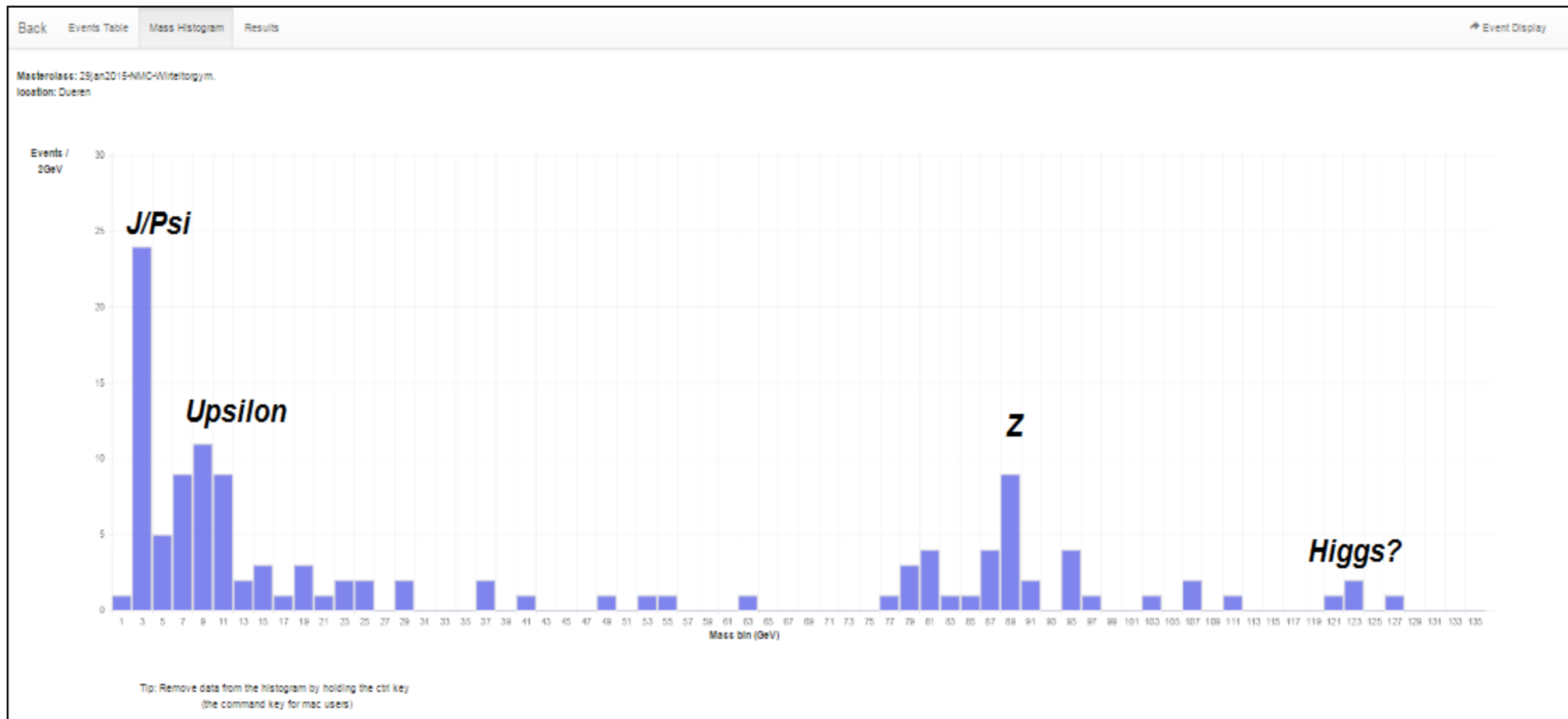
Zoo
 W-

Mass: 7.512 **Next**

Event index	Event number	Chosen Values	Mass
704	400912970	e;W+	
703	135353826	mu;W+	
702	500633024	Zoo	
701	329962807	Z;mu	50.642



What you see





What you see

Back Events Table Mass Histogram **Results**

Masterclass: 28Jan2015-NMC-Witelltoqym.
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



Additional step with CIMA

<https://www.i2u2.org/elab/cms/cima/auth.php>

username
Admin

password

Go!

MasterClass



Combined results





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*
- *Awesome CMS magnet*
- *How their day went*

Questions for me: kcecire@nd.edu