What do these “events” look like in the detector?

Outline of detectors

Tracking detector
Electromagnetic (EM) calorimeter
Hadronic calorimeter
Muon detector

Outline of calorimeter
Hits in tracking detectors
“Hits” are signals seen as particle passes through detector
Hits in electromagnetic calorimeter and hadronic calorimeter

We can “join the dots” to find particle trajectories or “tracks”

If a track points to an EM hit and
“matches” energy it is an ELECTRON

Another event

Some tracks, but no electrons.
Let’s zoom out a bit…..

CMS Experiment at the LHC, CERN
Data recorded: 2010-Oct-17 04:05:51.053525 GMT
Run / Event / LS: 148031 / 440964780 / 552
Hits in the muon detectors
More tracking detectors: the muon system

CMS Experiment at the LHC, CERN
Data recorded: 2010-Oct-17 04:05:51.053525 GMT
Run / Event / LS: 148031 / 440964780 / 552
If a track points to muon hits and
“matches” energy it is a MUON

We check that the energy in an event is balanced.
Any imbalance we call “Missing energy” (shown by pink dashed line)

Missing energy is attributed to neutrinos (ν) as they interact very weakly.

Now, we can identify particles. What does this tell us about the events?

CMS Experiment at the LHC, CERN
Data recorded: 2010-Oct-17 05:30:37.689383 GMT
Run / Event / LS: 148031 / 598516957 / 770
2 muons: Z→mumu

CMS Experiment at the LHC, CERN
Data recorded: 2010-Aug-03 03:01:03.203308 GMT
Run / Event / LS: 142189 / 74250285 / 111
2 electrons: $Z \rightarrow e^+e^-$

CMS Experiment at the LHC, CERN
Data recorded: 2010-Sep-30 01:06:45.056337 GMT
Run / Event / LS: 146944 / 231453642 / 275
Electron and neutrino:
$W^- \rightarrow e^- \nu$

QUIZ

CMS Experiment at the LHC, CERN
Data recorded: 2010-Oct-17 04:07:21.614527 GMT
Run / Event / LS: 148031 / 443826790 / 556
QUIZ : EVENT 1

CMS Experiment at the LHC, CERN
Data recorded: 2010-Sep-30 01:06:57.652395 GMT
Run / Event / LS: 146944 / 232248618 / 276
QUIZ : EVENT 2

CMS Experiment at the LHC, CERN
Data recorded: 2010-Aug-03 04:29:06.673141 GMT
Run / Event / LS: 142191 / 41148625 / 67

QUIZ : EVENT 3

CMS Experiment at the LHC, CERN
Data recorded: 2010-Sep-30 00:46:58.911784 GMT
Run / Event / LS: 146944 / 156416091 / 224
QUIZ : EVENT 4

OK I told you this is a Z->mumu

BUT how do we know??

We only SEE the 2 muons

This event looks very similar but is actually from a different particle (J/ψ) decaying to $\mu^+\mu^-$