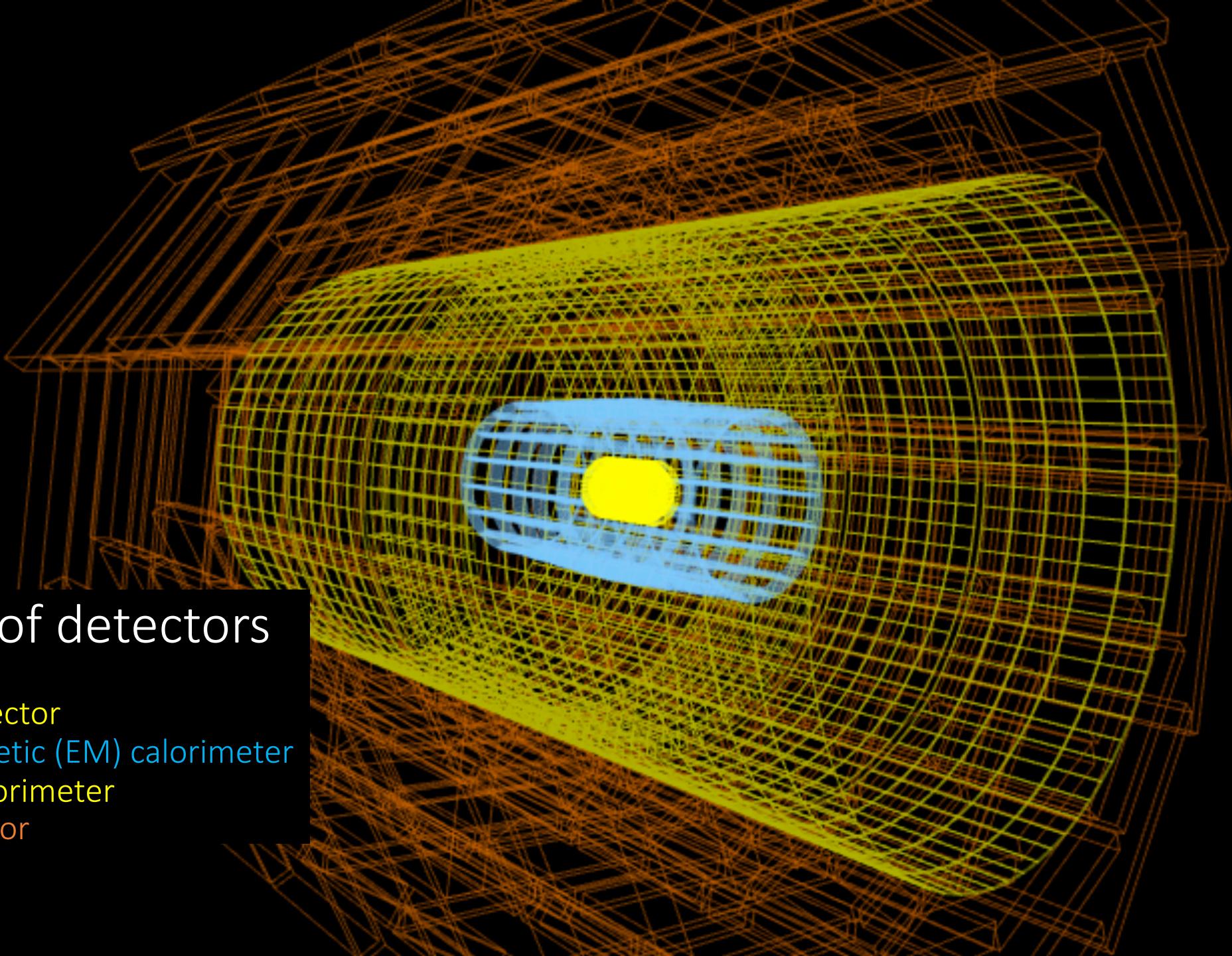


What do these “events” look  
like in the detector?



## Outline of detectors

Tracking detector

Electromagnetic (EM) calorimeter

Hadronic calorimeter

Muon detector

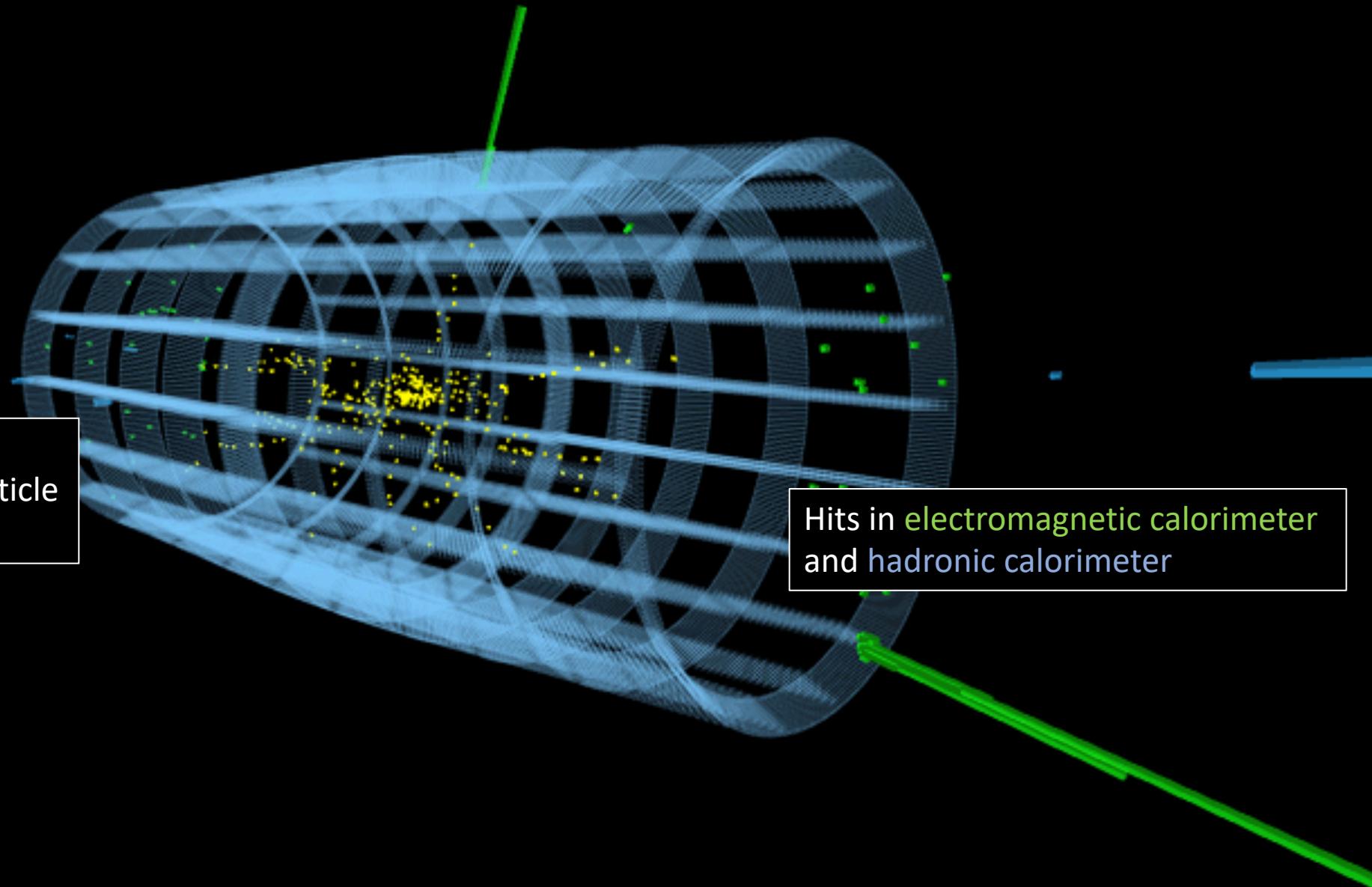


Outline of calorimeter

Hits in **tracking detectors**

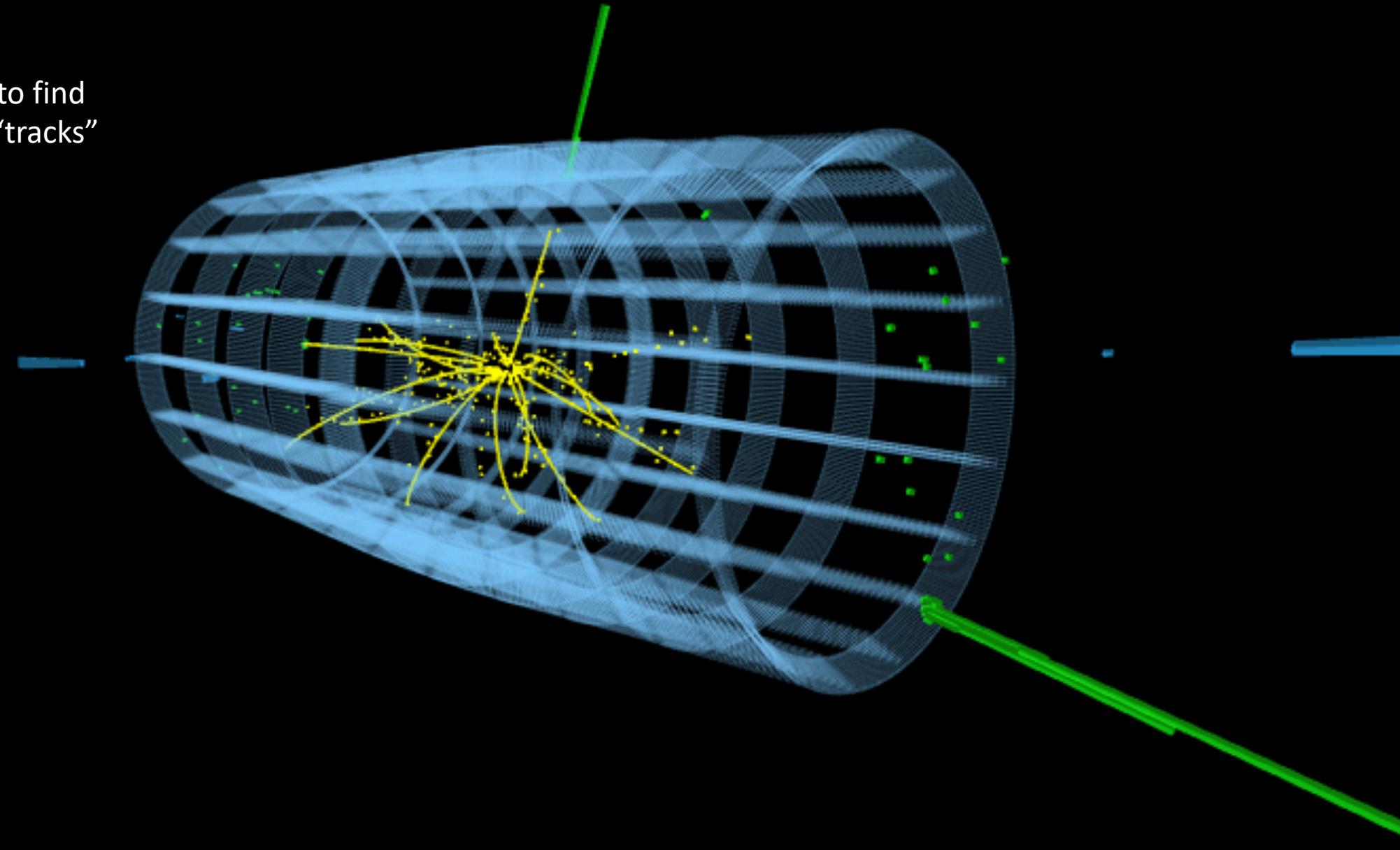
“Hits” are signals seen as particle passes through detector

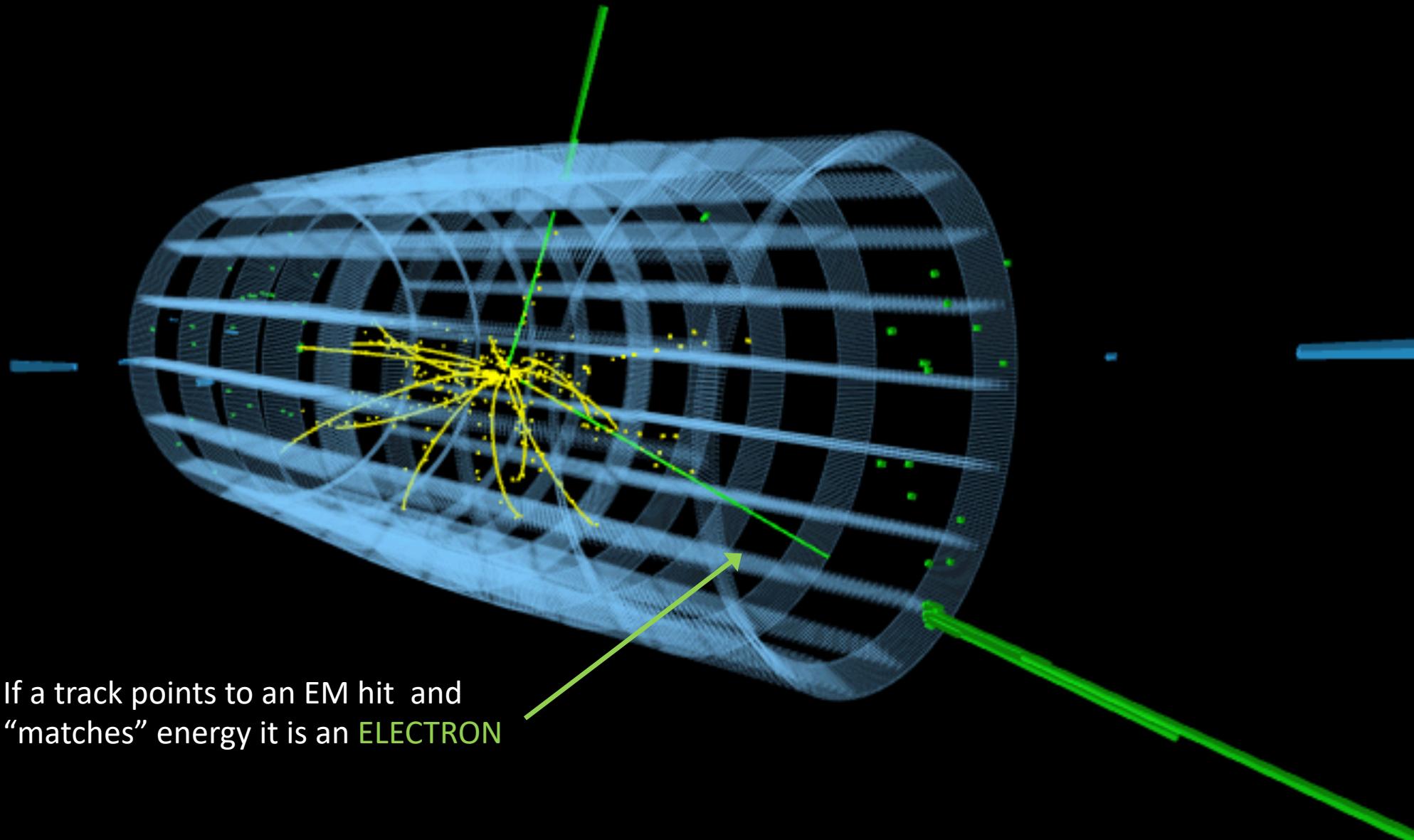
Hits in **electromagnetic calorimeter**  
and **hadronic calorimeter**





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





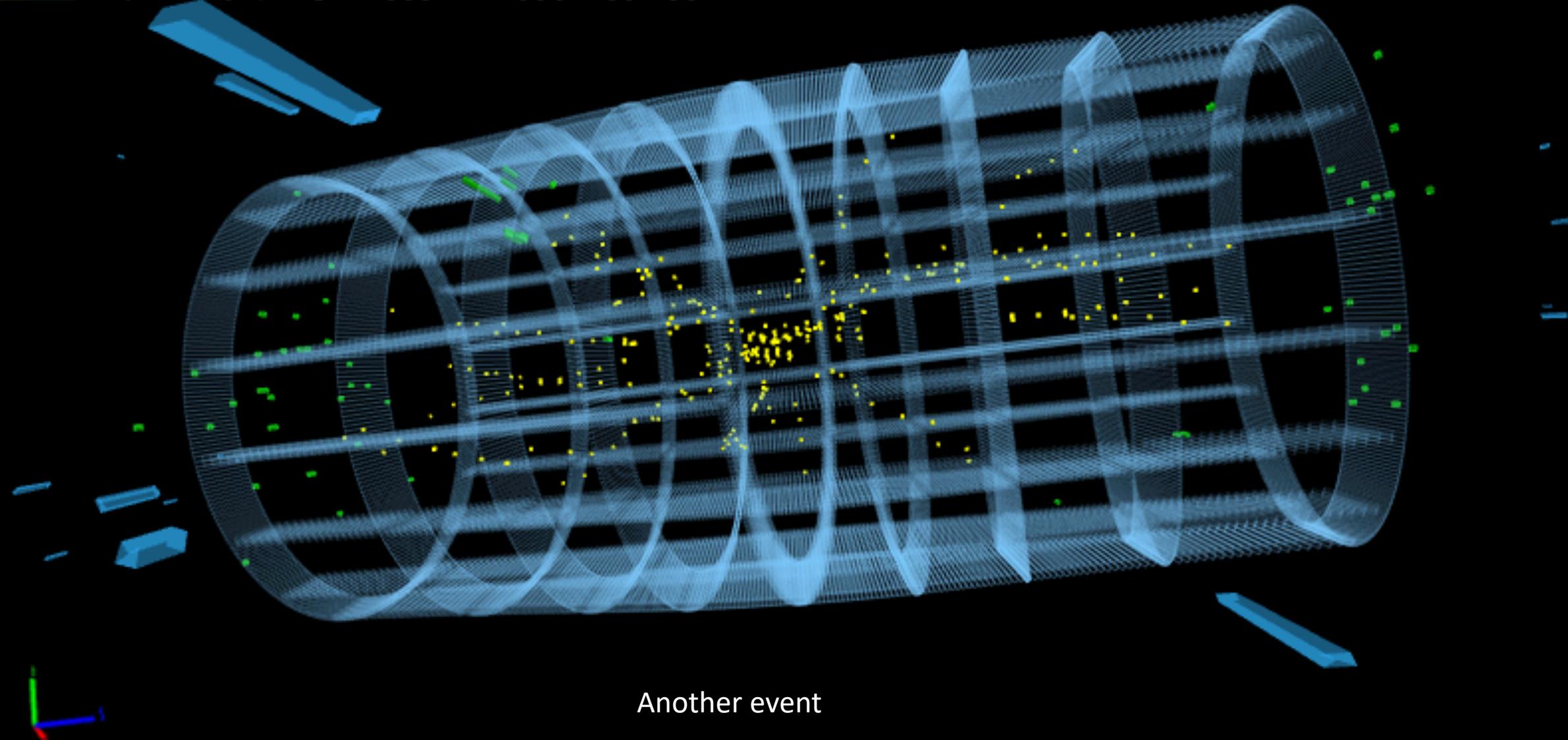
If a track points to an EM hit and  
“matches” energy it is an ELECTRON



CMS Experiment at the LHC, CERN

Data recorded: 2010-Oct-17 04:05:51.053525 GMT

Run / Event / LS: 148031 / 440964780 / 552

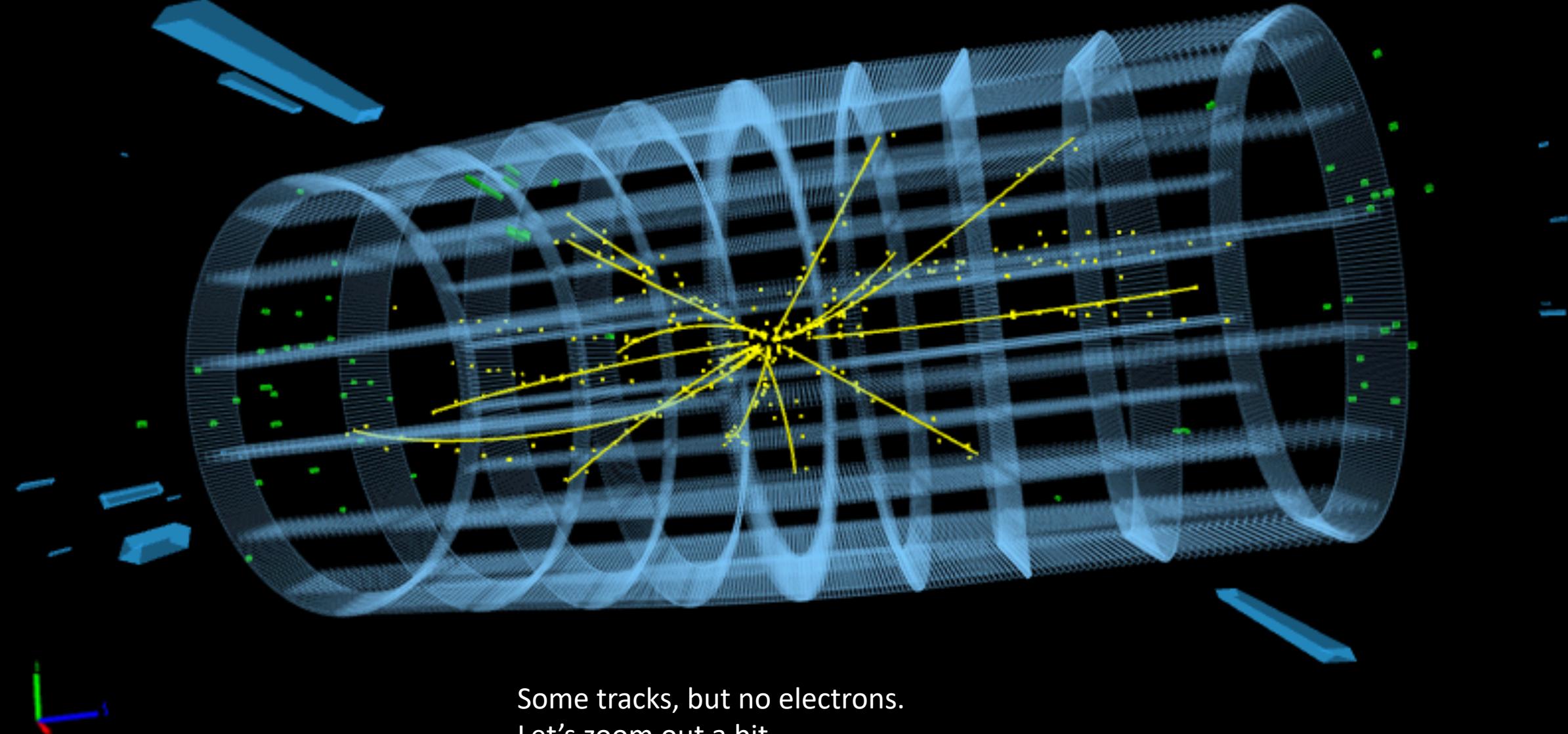




CMS Experiment at the LHC, CERN

Data recorded: 2010-Oct-17 04:05:51.053525 GMT

Run / Event / LS: 148031 / 440964780 / 552



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



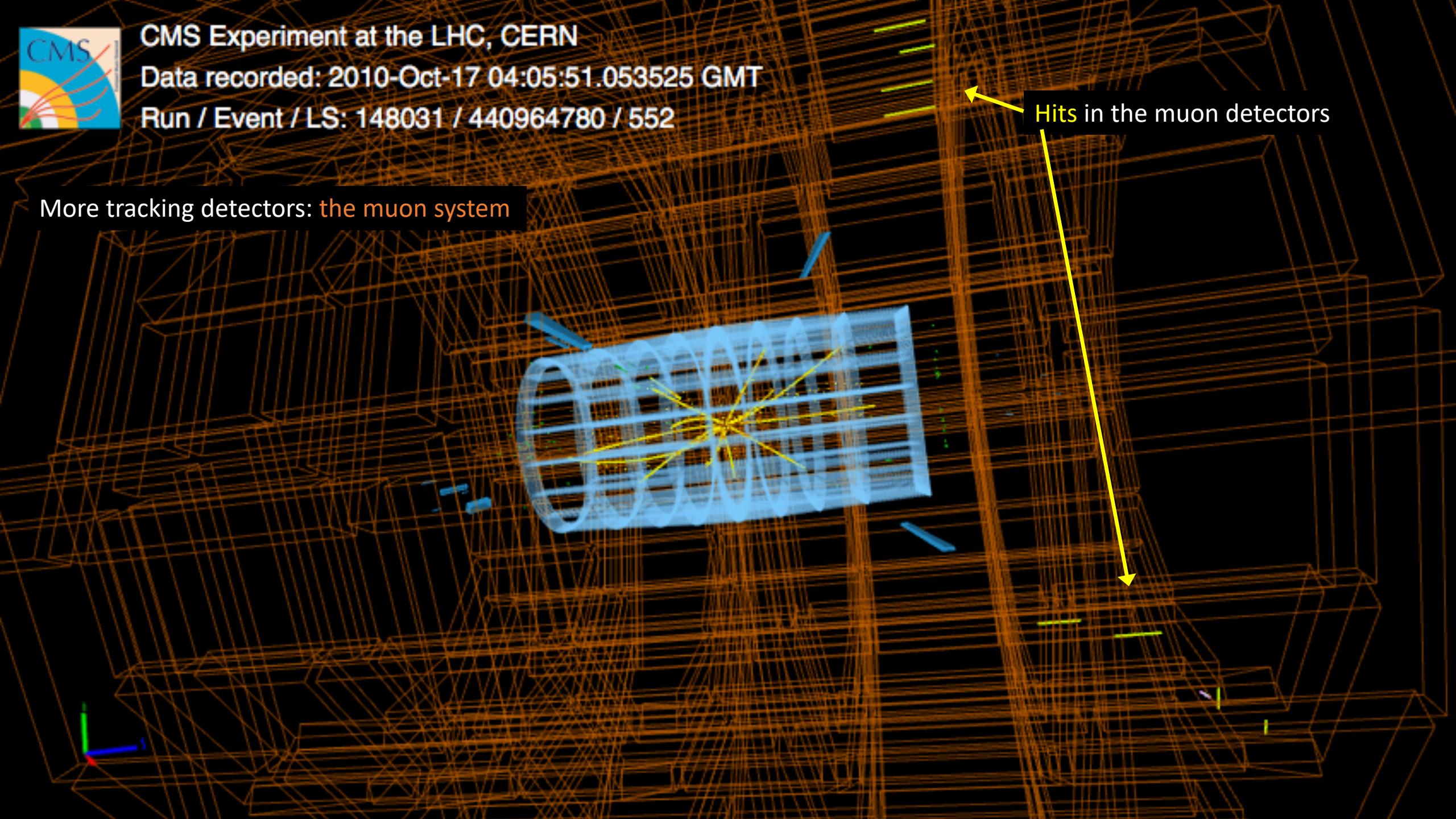
CMS Experiment at the LHC, CERN

Data recorded: 2010-Oct-17 04:05:51.053525 GMT

Run / Event / LS: 148031 / 440964780 / 552

More tracking detectors: the muon system

Hits in the muon detectors

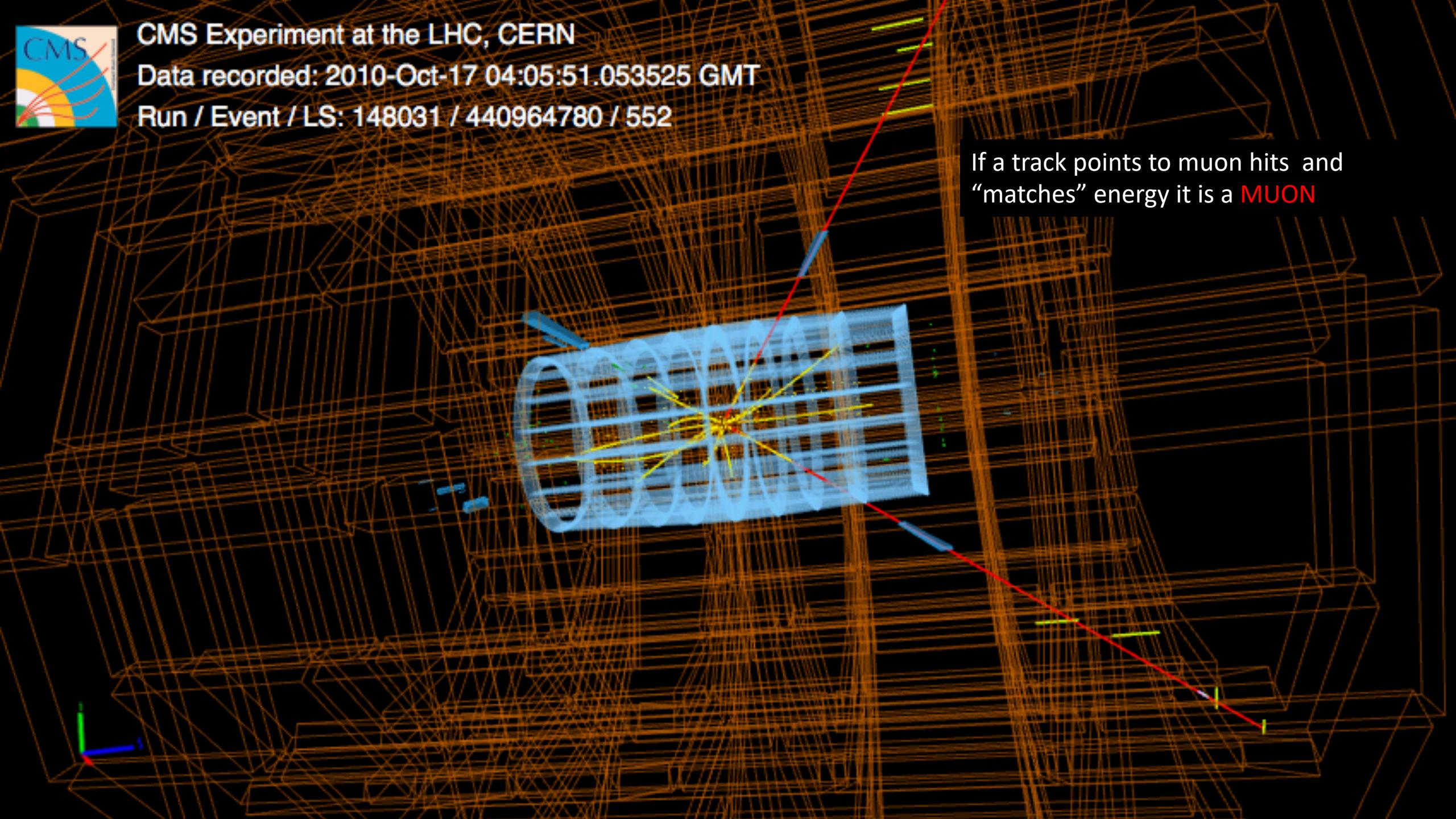




CMS Experiment at the LHC, CERN

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 can find particles.  
What does this tell us about the  
events?

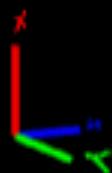
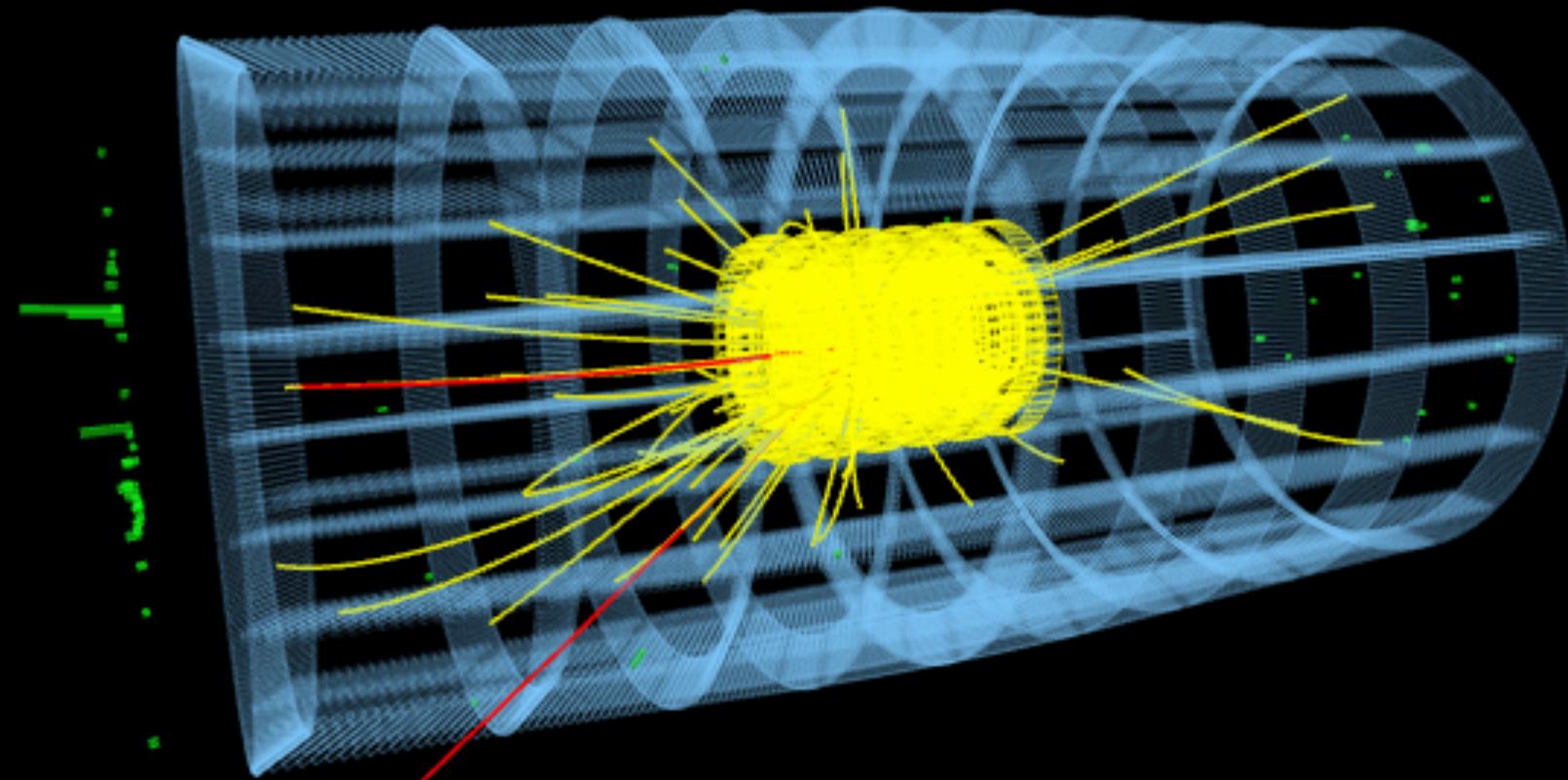


CMS Experiment at the LHC, CERN

Data recorded: 2010-Jul-14 08:53:32.529842 GMT

Run / Event / LS: 140124 / 1008846067 / 1138

2 muons:  $Z \rightarrow \mu\mu$



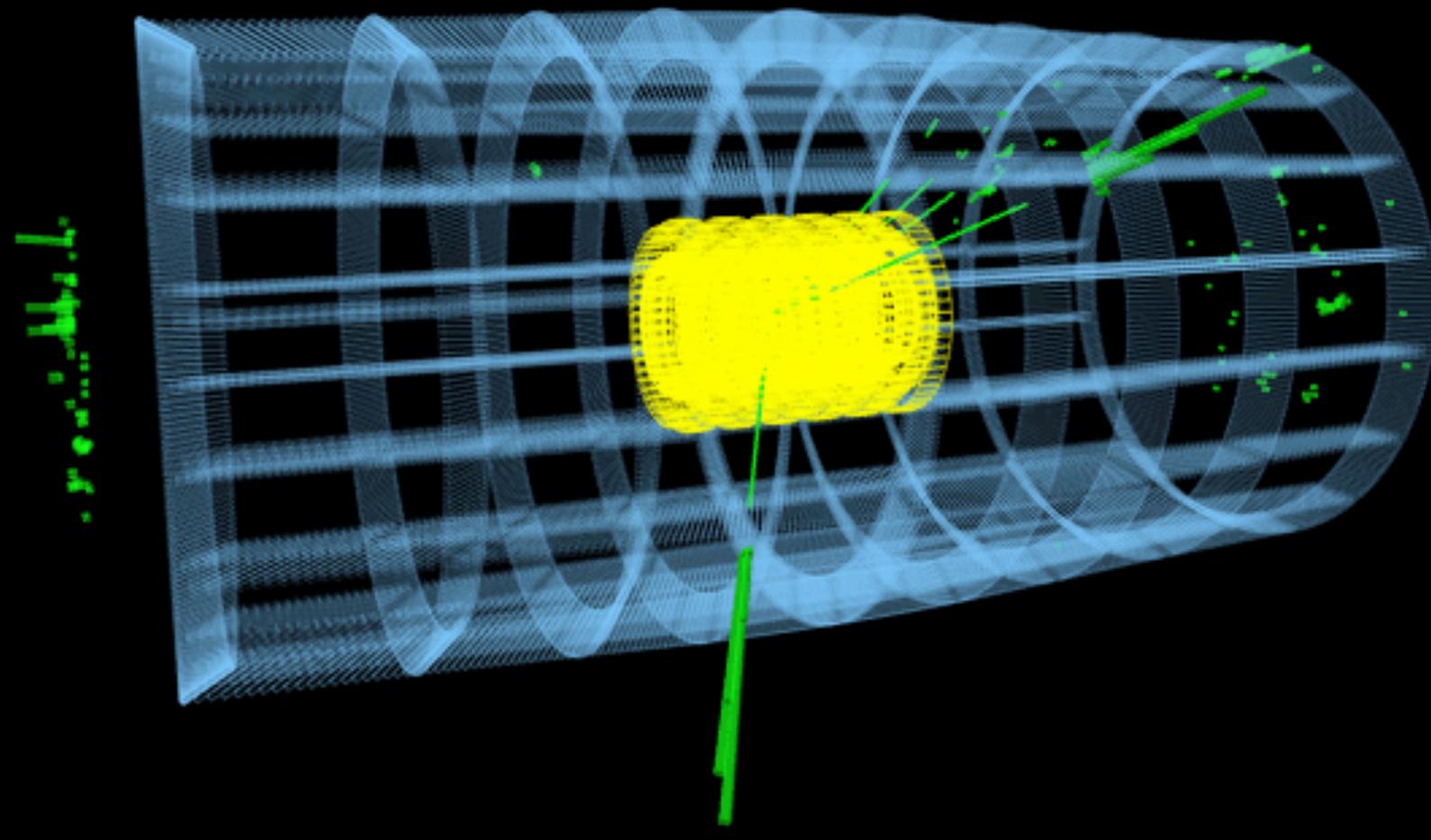


CMS Experiment at the LHC, CERN

Data recorded: 2010-Aug-03 04:19:03.948825 GMT

Run / Event / LS: 142191 / 25487594 / 41

2 electrons:  $Z \rightarrow e^+e^-$



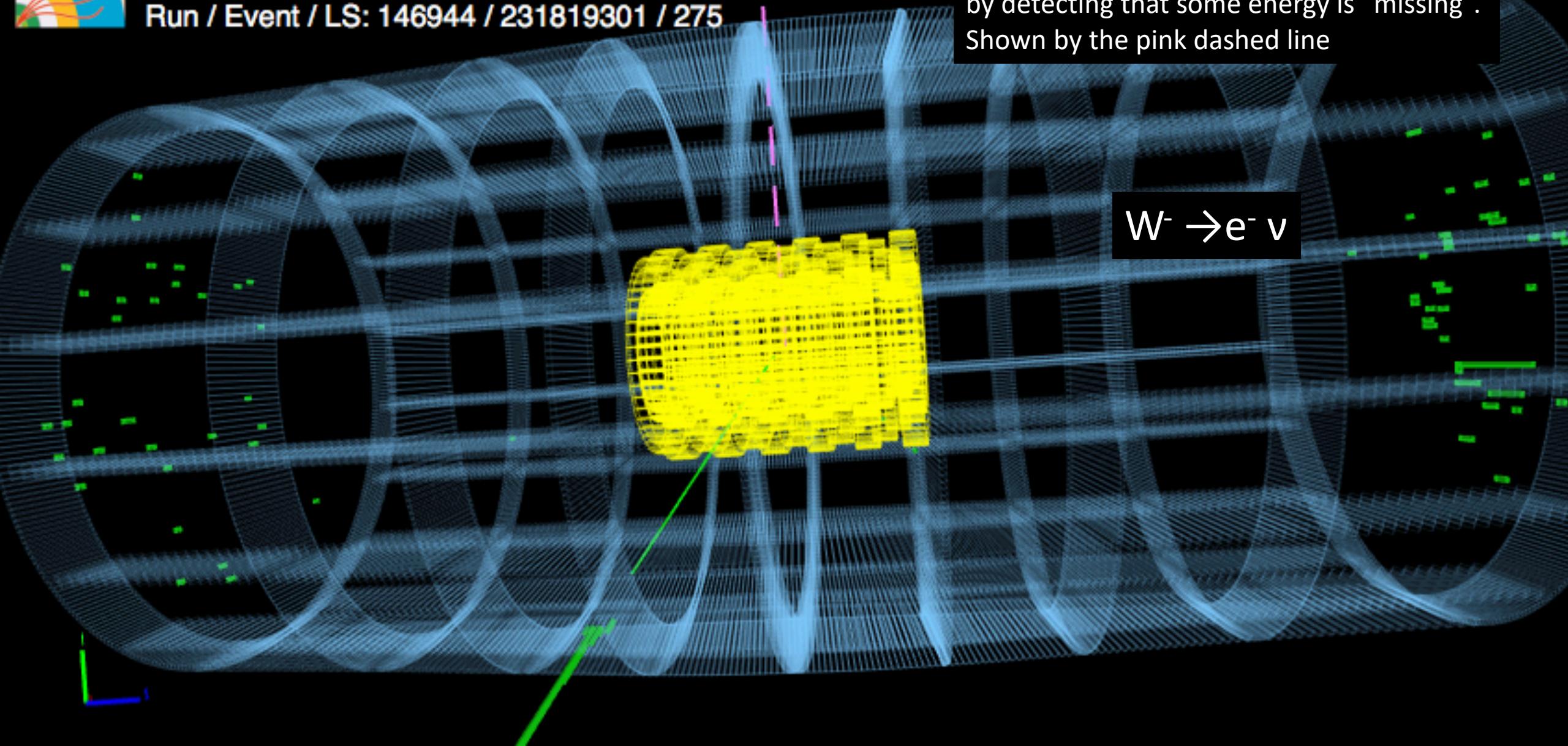


CMS Experiment at the LHC, CERN

Data recorded: 2010-Sep-30 01:06:50.841405 GMT

Run / Event / LS: 146944 / 231819301 / 275

Remember the neutrino ( $\nu$ ). We only see it by detecting that some energy is “missing”. Shown by the pink dashed line



**QUIZ**



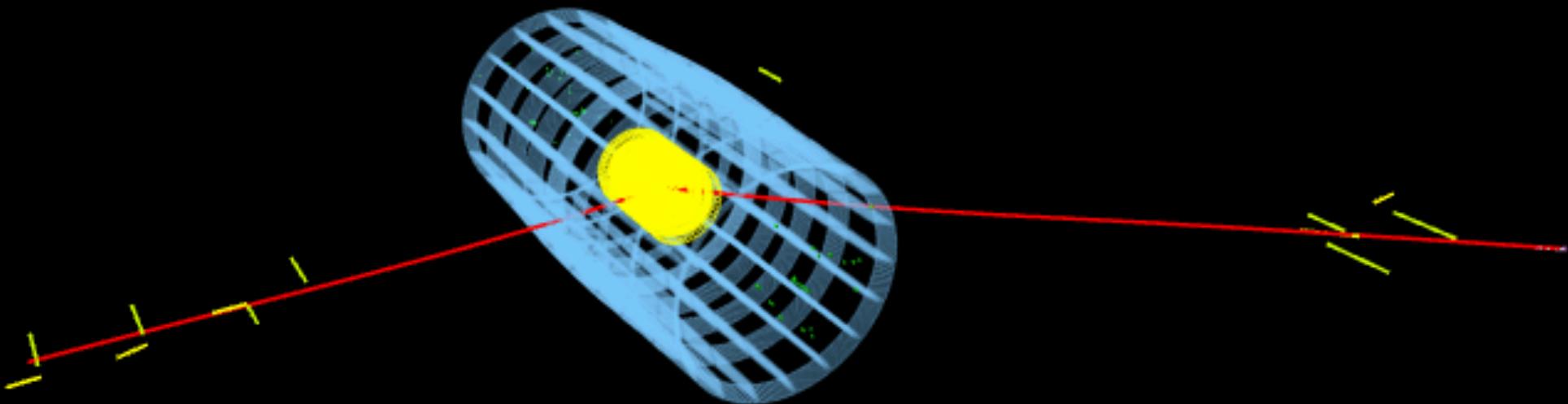


CMS Experiment at the LHC, CERN

Data recorded: 2010-Oct-17 04:07:21.614527 GMT

Run / Event / LS: 148031 / 443826790 / 556

## QUIZ : EVENT 1



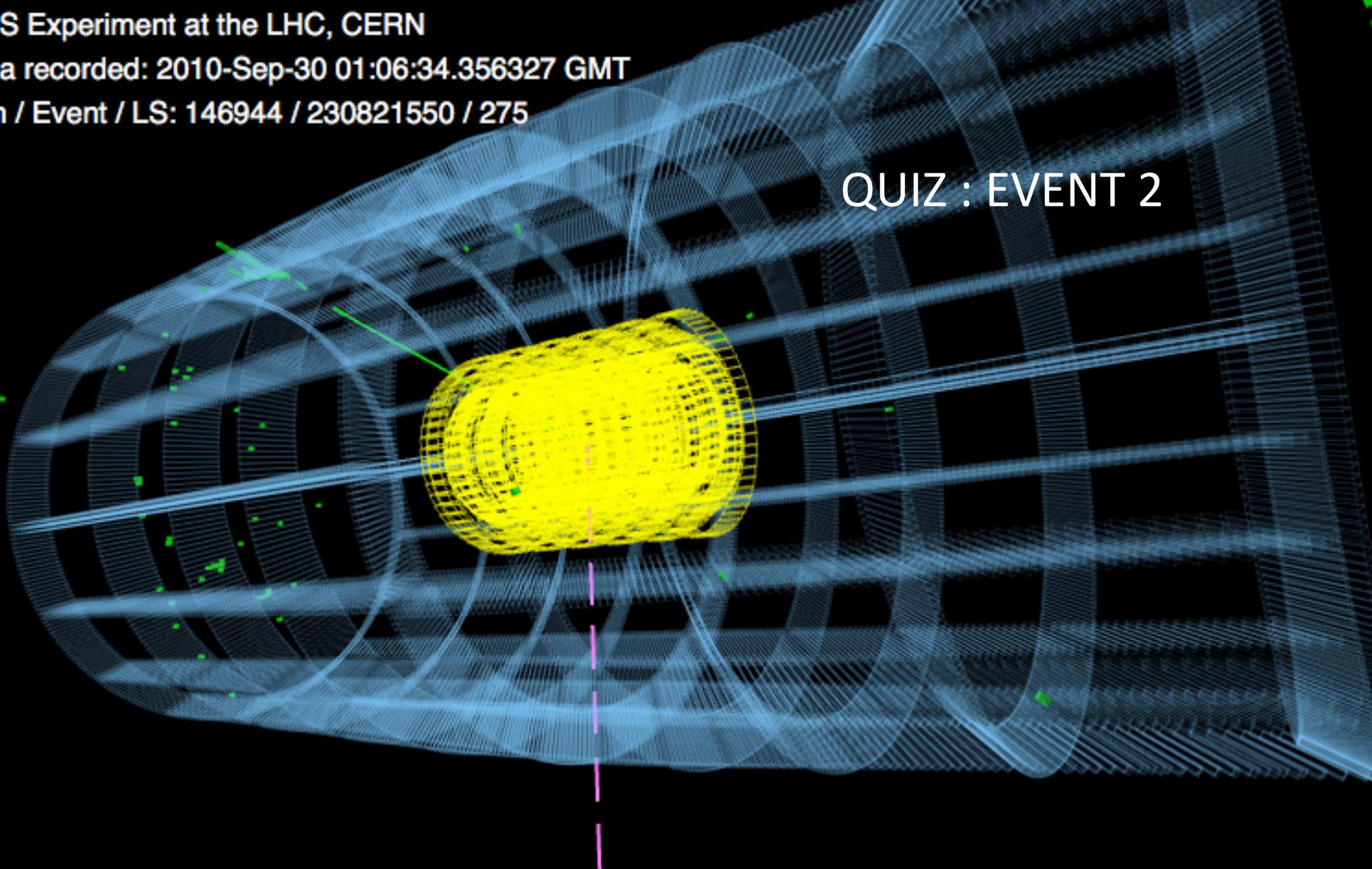


CMS Experiment at the LHC, CERN

Data recorded: 2010-Sep-30 01:06:34.356327 GMT

Run / Event / LS: 146944 / 230821550 / 275

QUIZ : EVENT 2



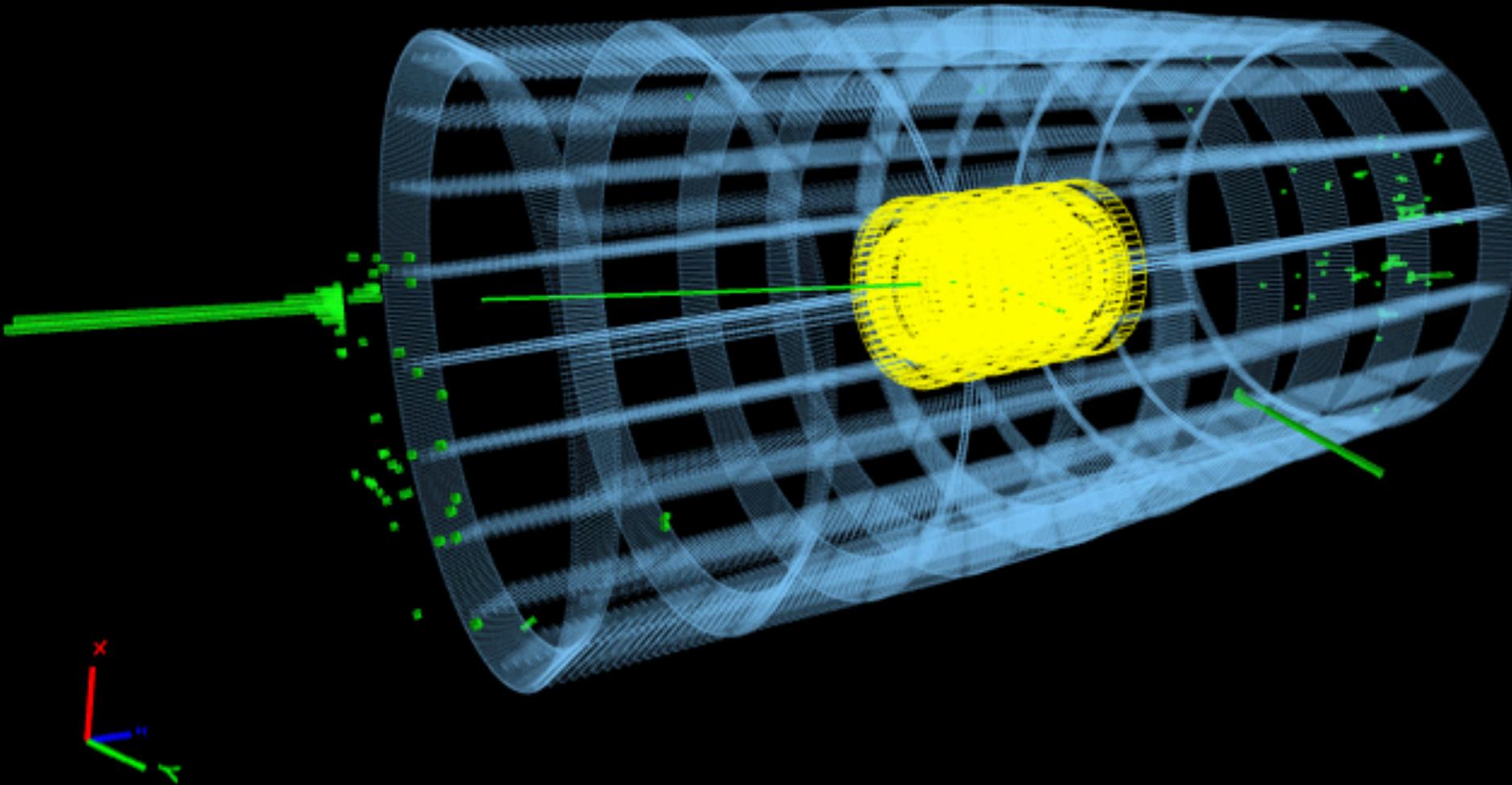


CMS Experiment at the LHC, CERN

Data recorded: 2010-Aug-03 03:28:38.504033 GMT

Run / Event / LS: 142189 / 121149731 / 182

## QUIZ : EVENT 3



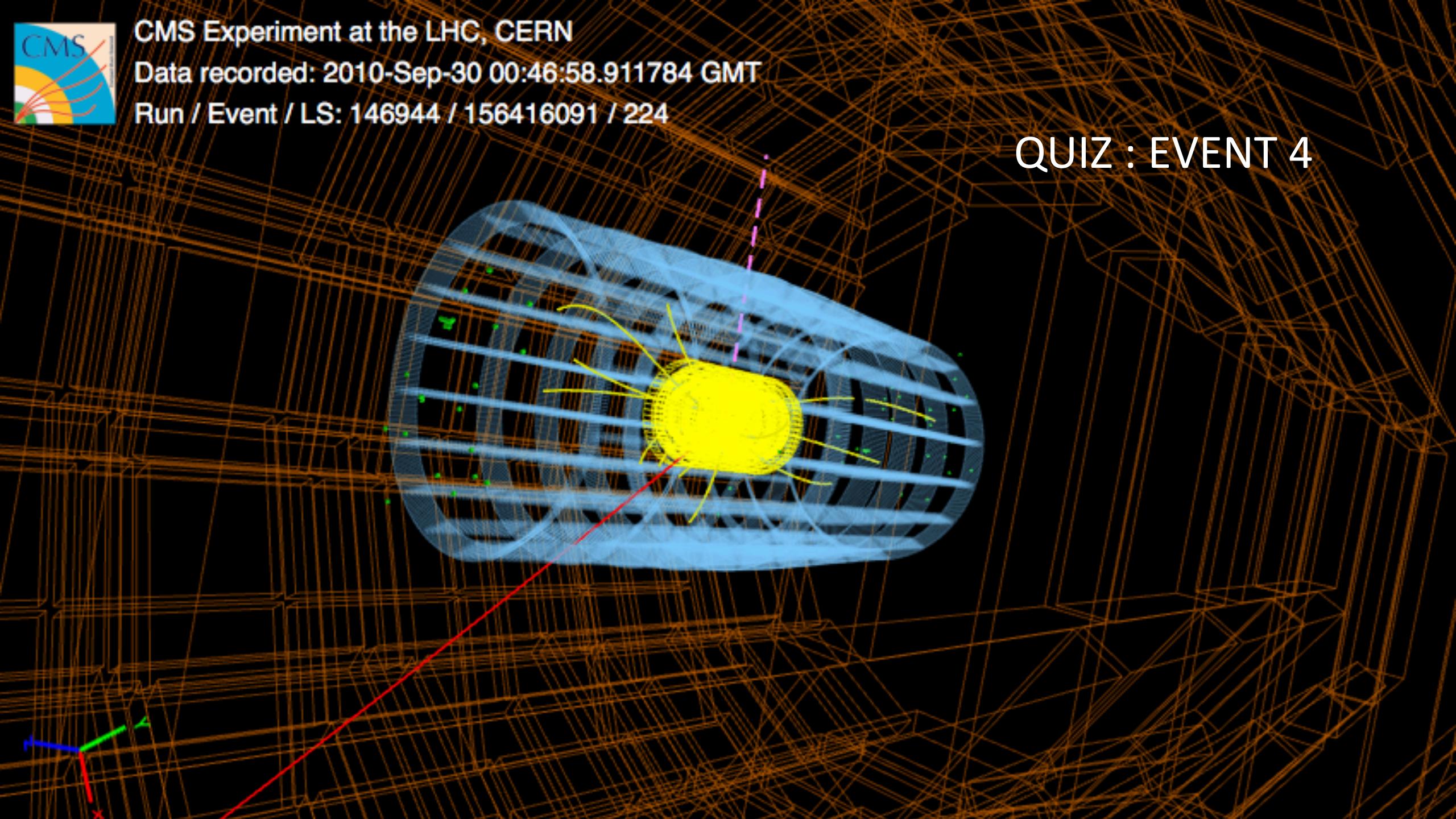


CMS Experiment at the LHC, CERN

Data recorded: 2010-Sep-30 00:46:58.911784 GMT

Run / Event / LS: 146944 / 156416091 / 224

QUIZ : EVENT 4







CMS Experiment at the LHC, CERN

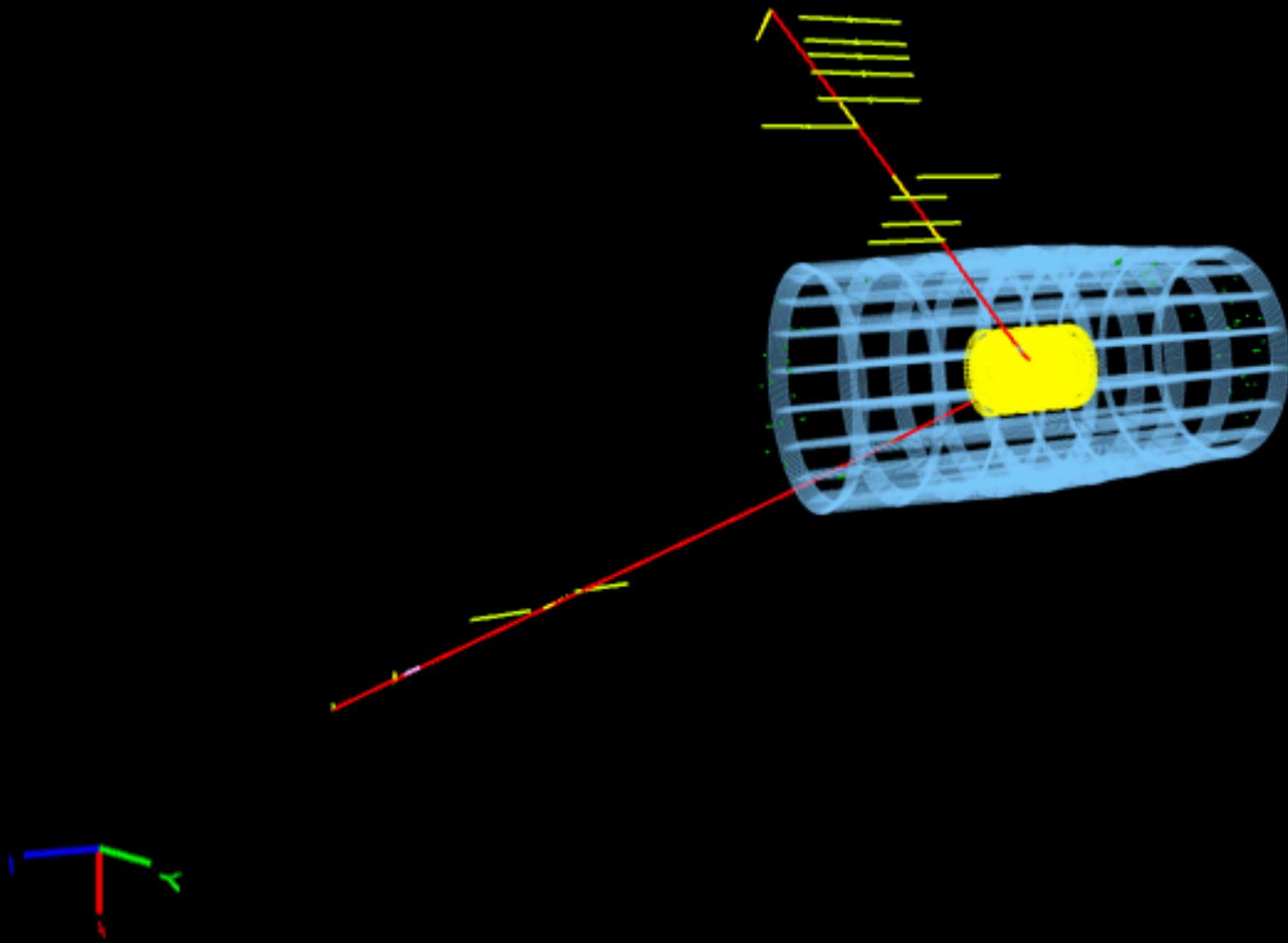
Data recorded: 2010-Oct-17 04:05:51.053525 GMT

Run / Event / LS: 148031 / 440964780 / 552

OK I told you this is a  $Z \rightarrow \mu\mu$

BUT how do we know??

We only SEE the 2 muons





CMS Experiment at the LHC, CERN

Data recorded: 2010-Jul-14 08:53:10.143827 GMT

Run / Event / LS: 140124 / 1008000431 / 1137

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

