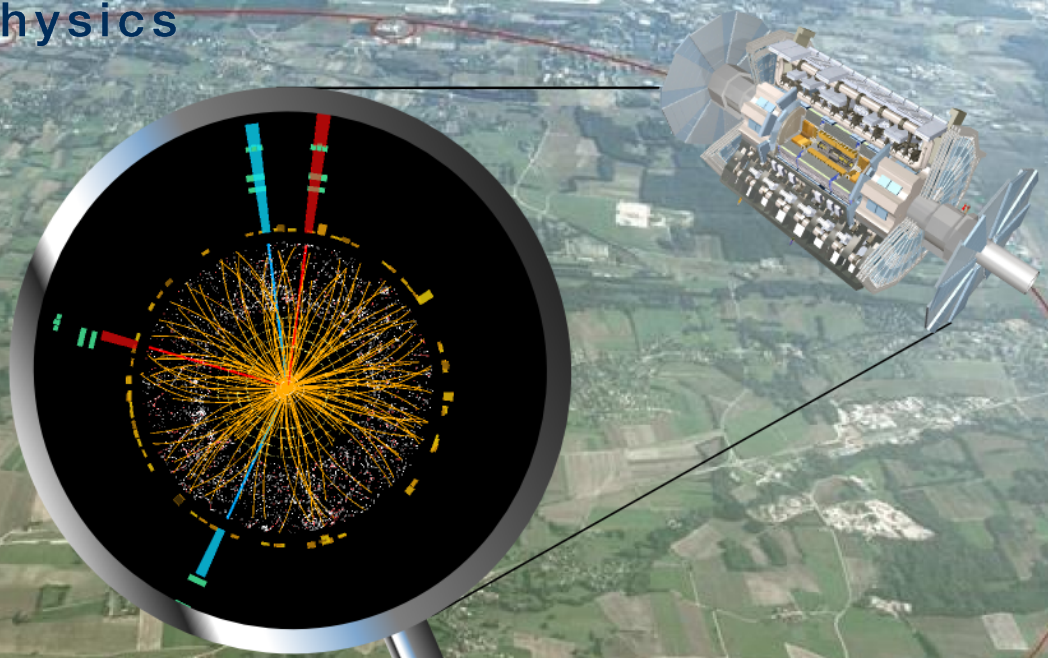
How to detect particles in ATLAS

INTERNATIONAL MASTERCLASSES

hands on particle physics



Centre de physique des particules de Marseille

cnrs dépasser les frontières

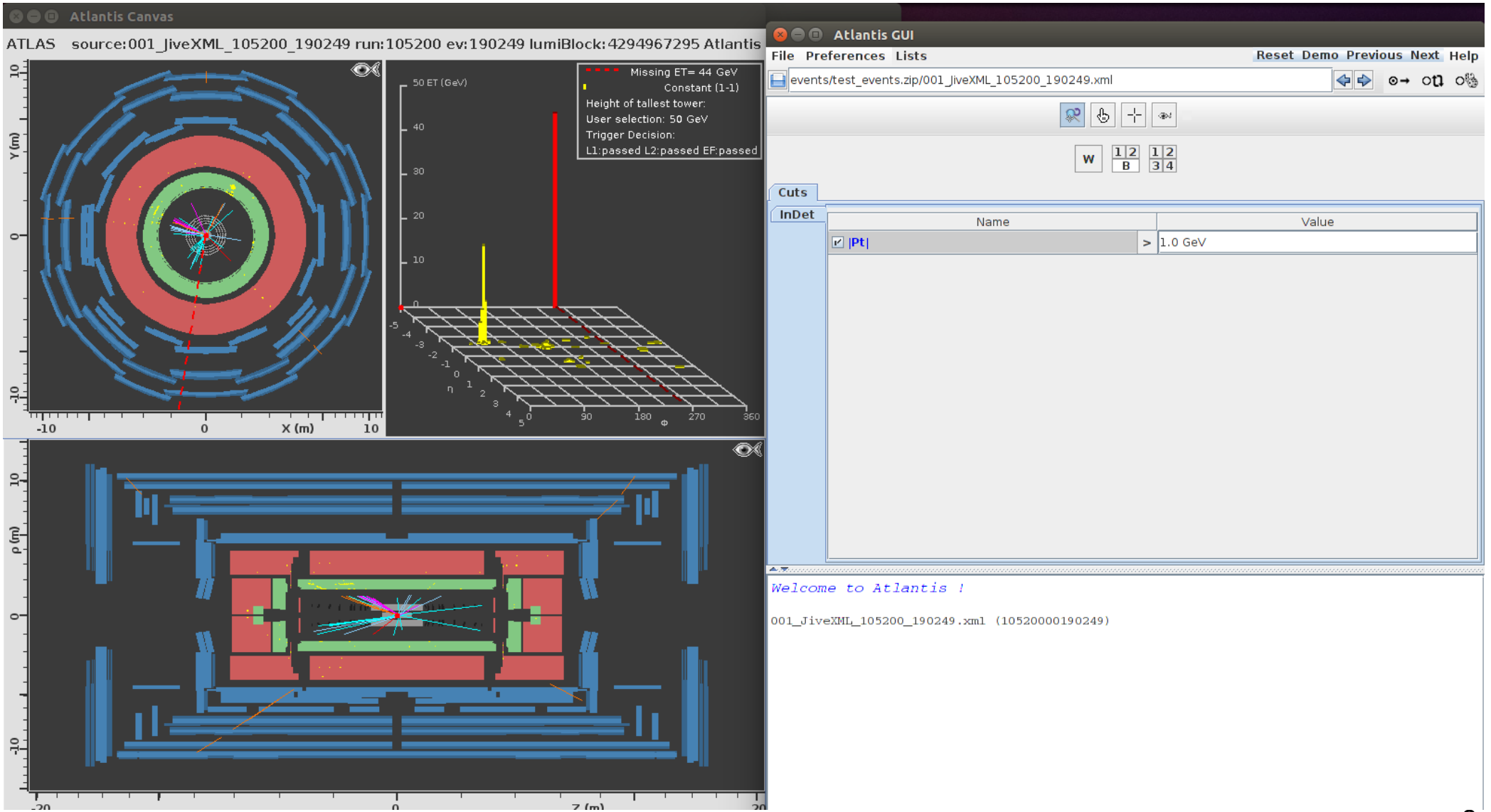
IN2P3 Les deux infinis

Aix*Marseille université

CENTRE DE PHYSIQUE DES PARTICULES DE MARSEILLE

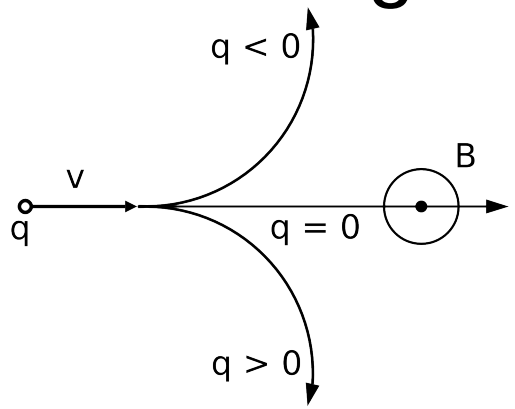
CPPM

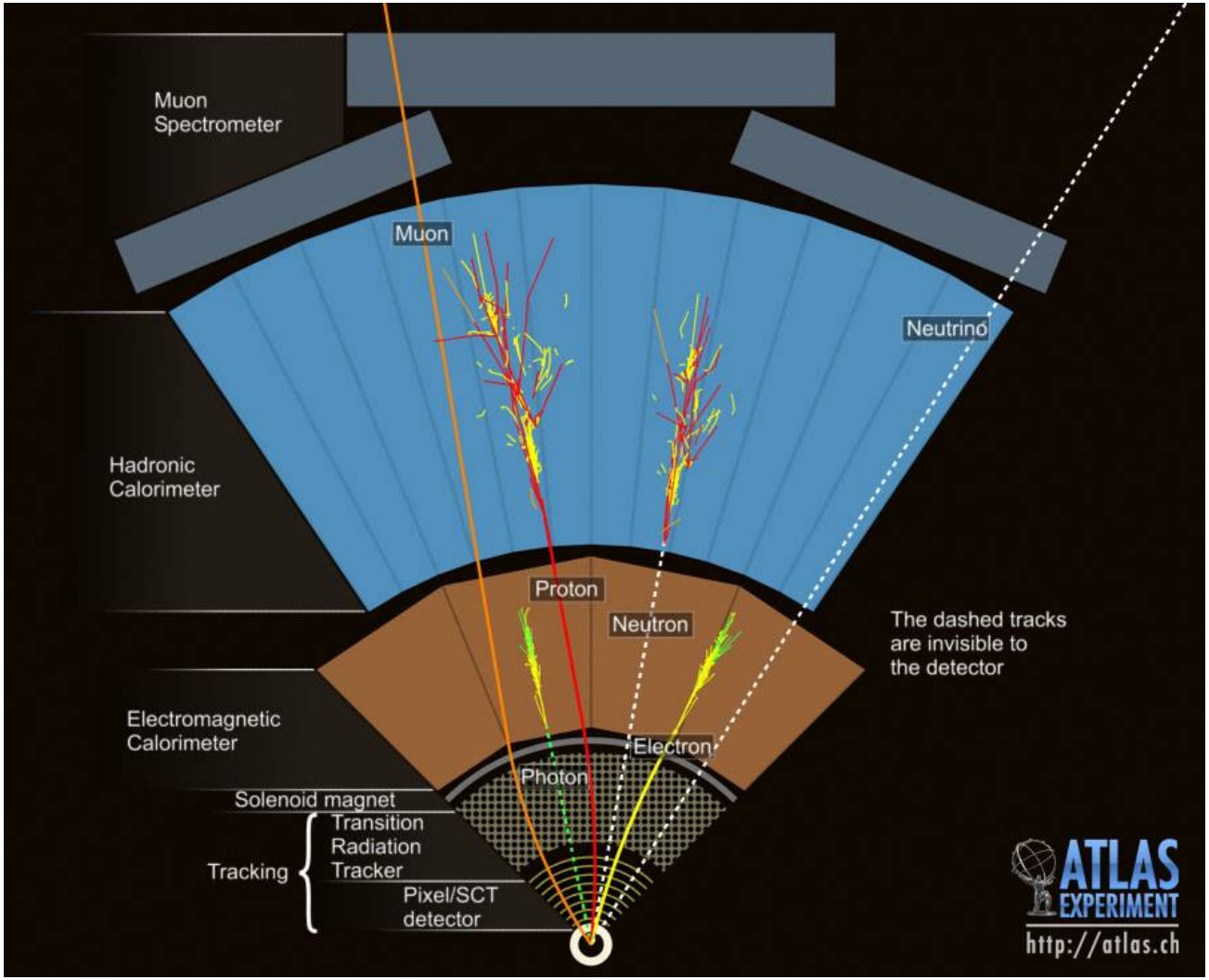
Using Minerva to identify events



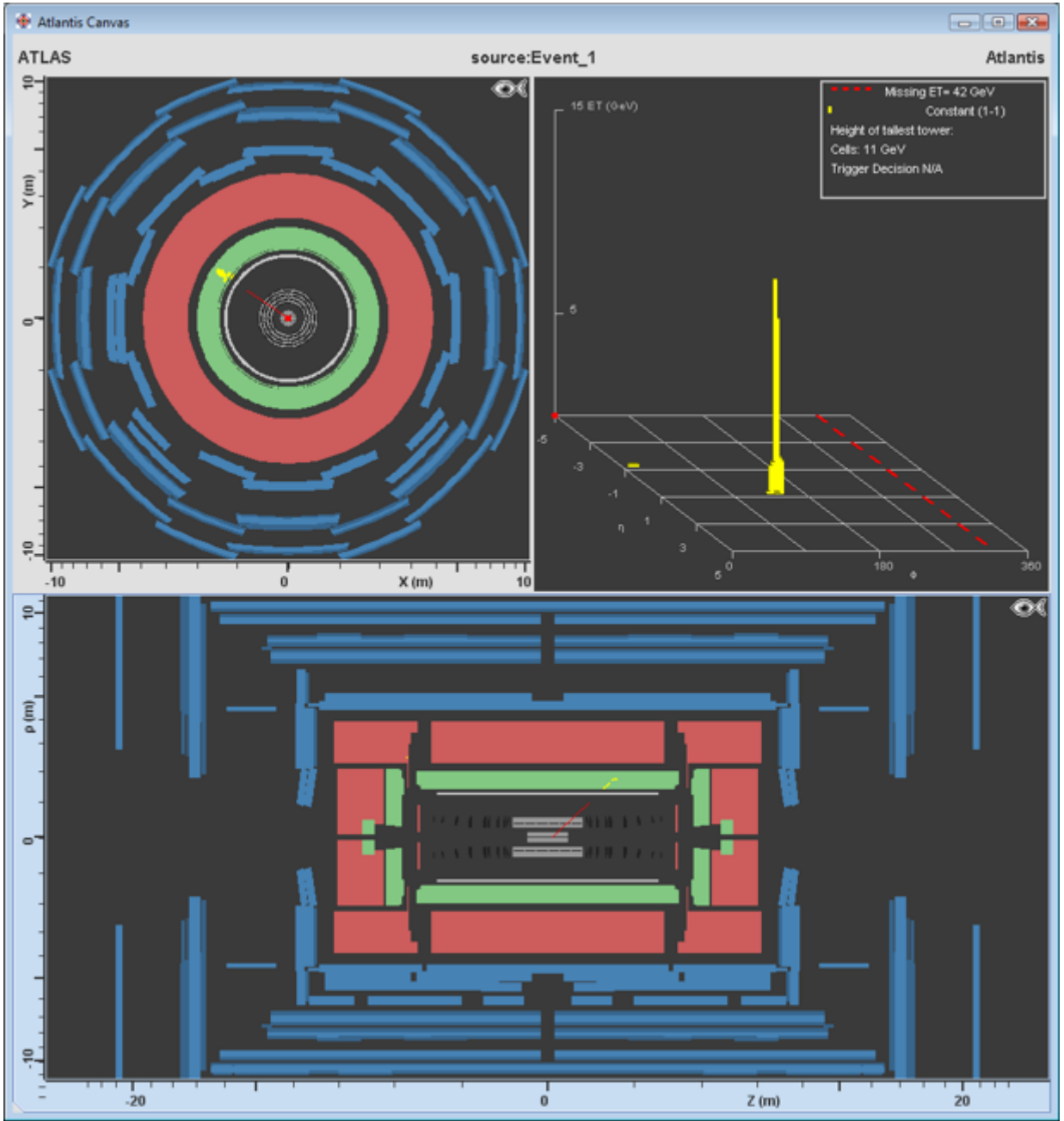
Electrons/positrons and photons identification

- Shower in the EM calorimeter
- e^+/e^- : charged particle, track in the tracker
- Curvature of the track → sign of the electric charge





Electrons/positrons identification with Minerva



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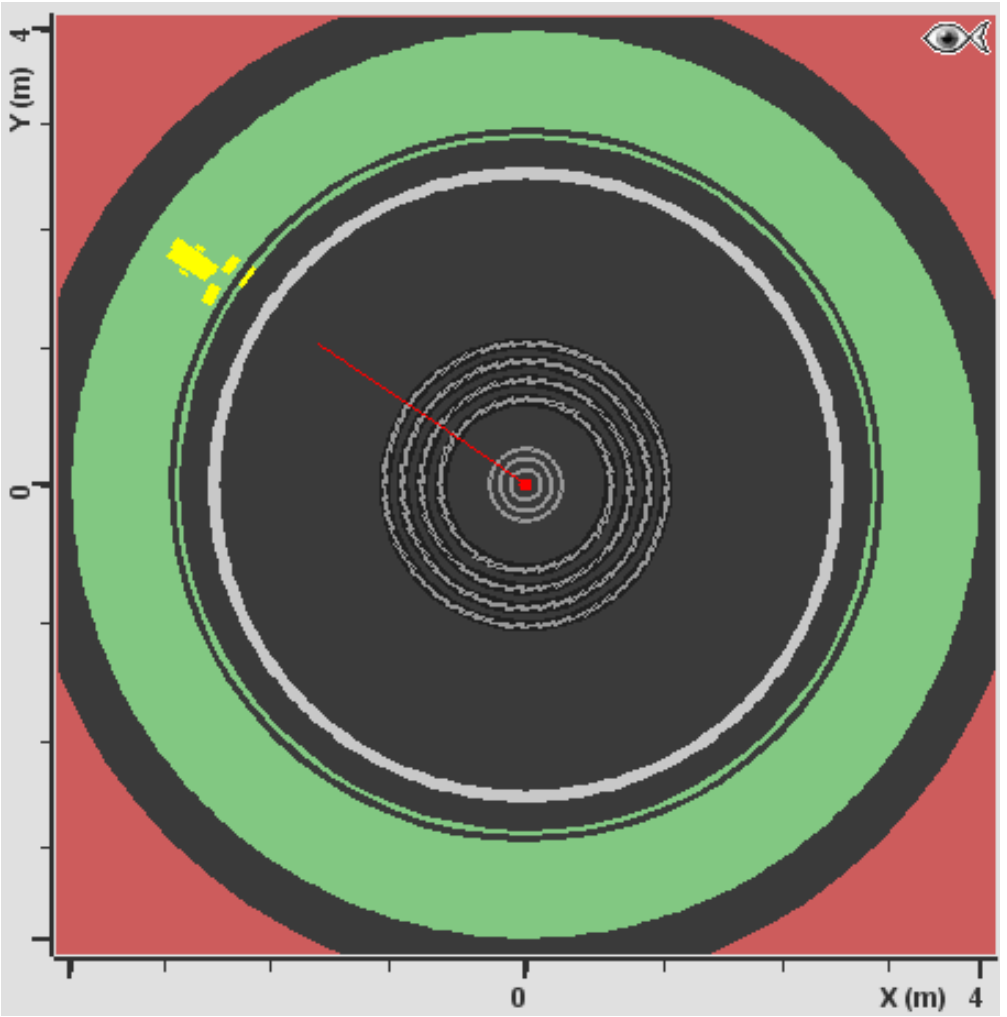
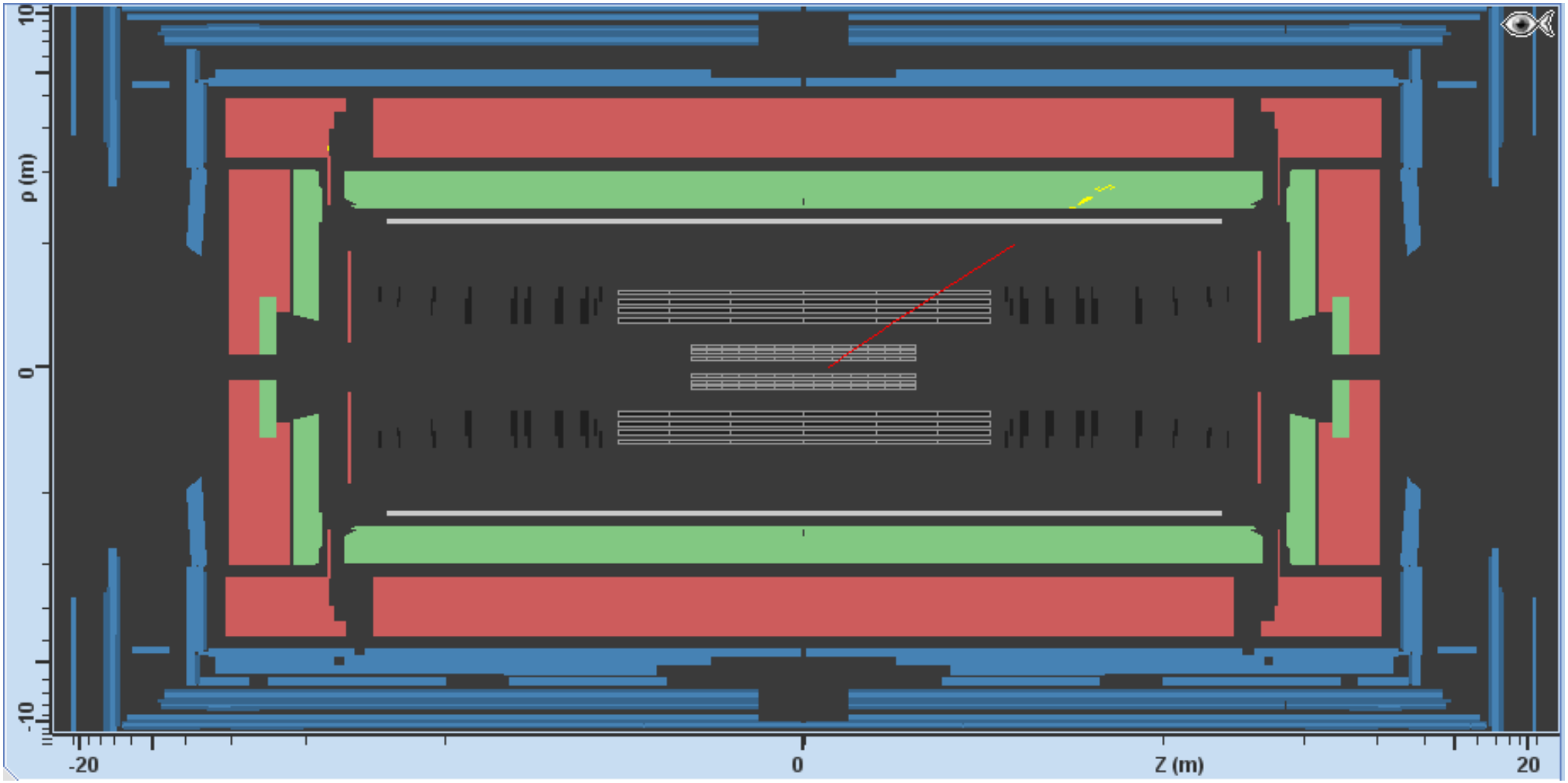


- Track in the tracker
- Energy in the calorimeter

Electrons/positrons identification with Minerva



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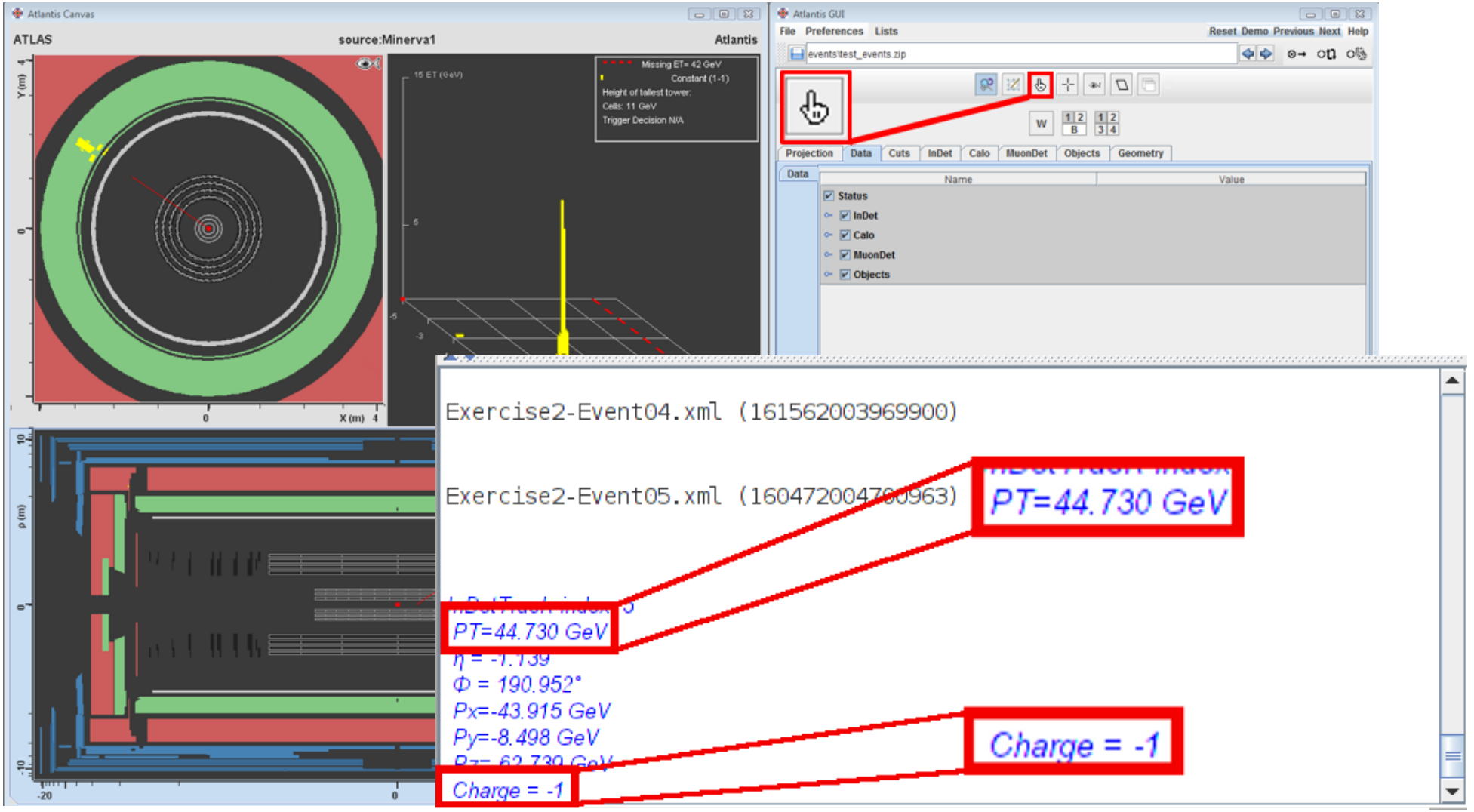
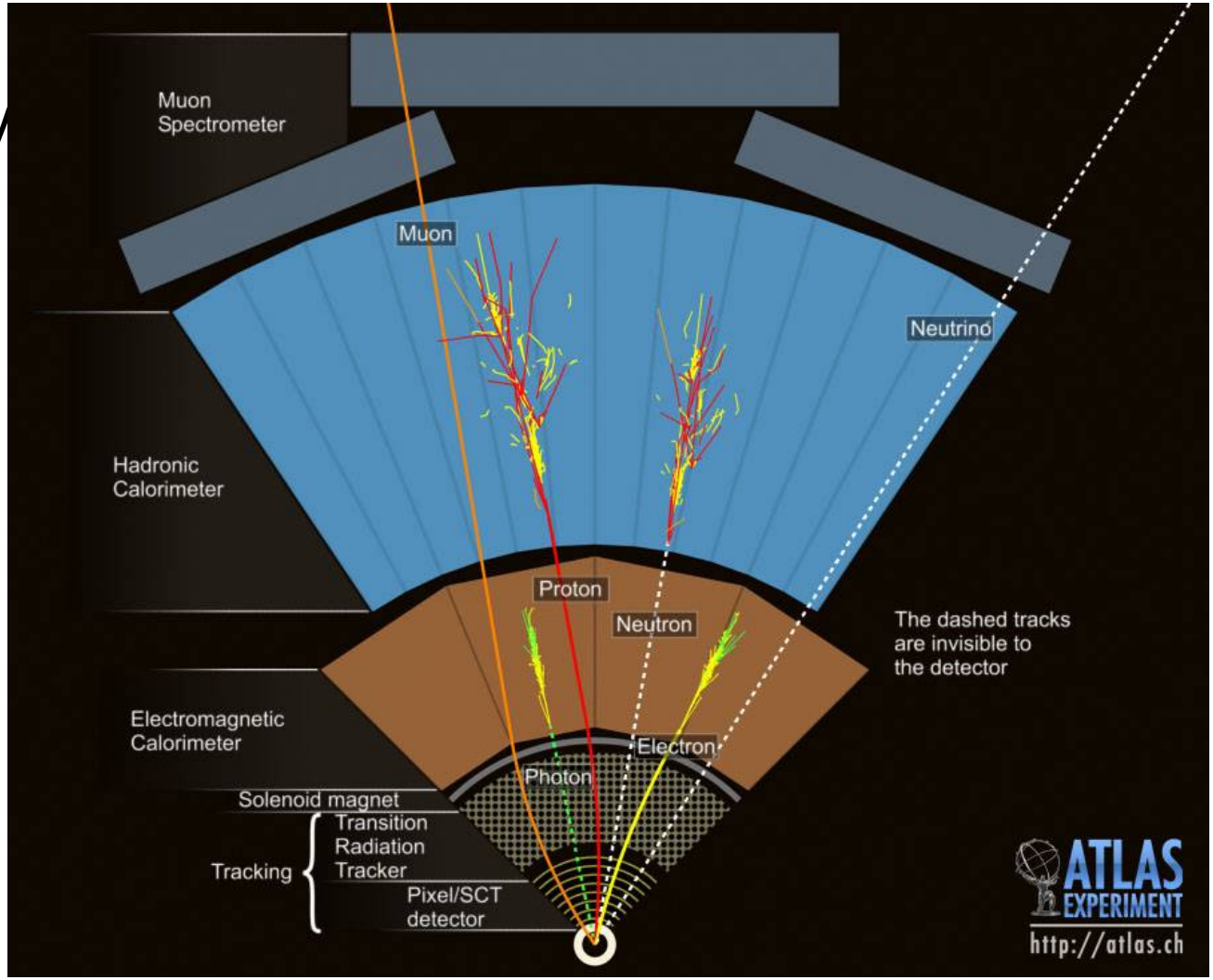


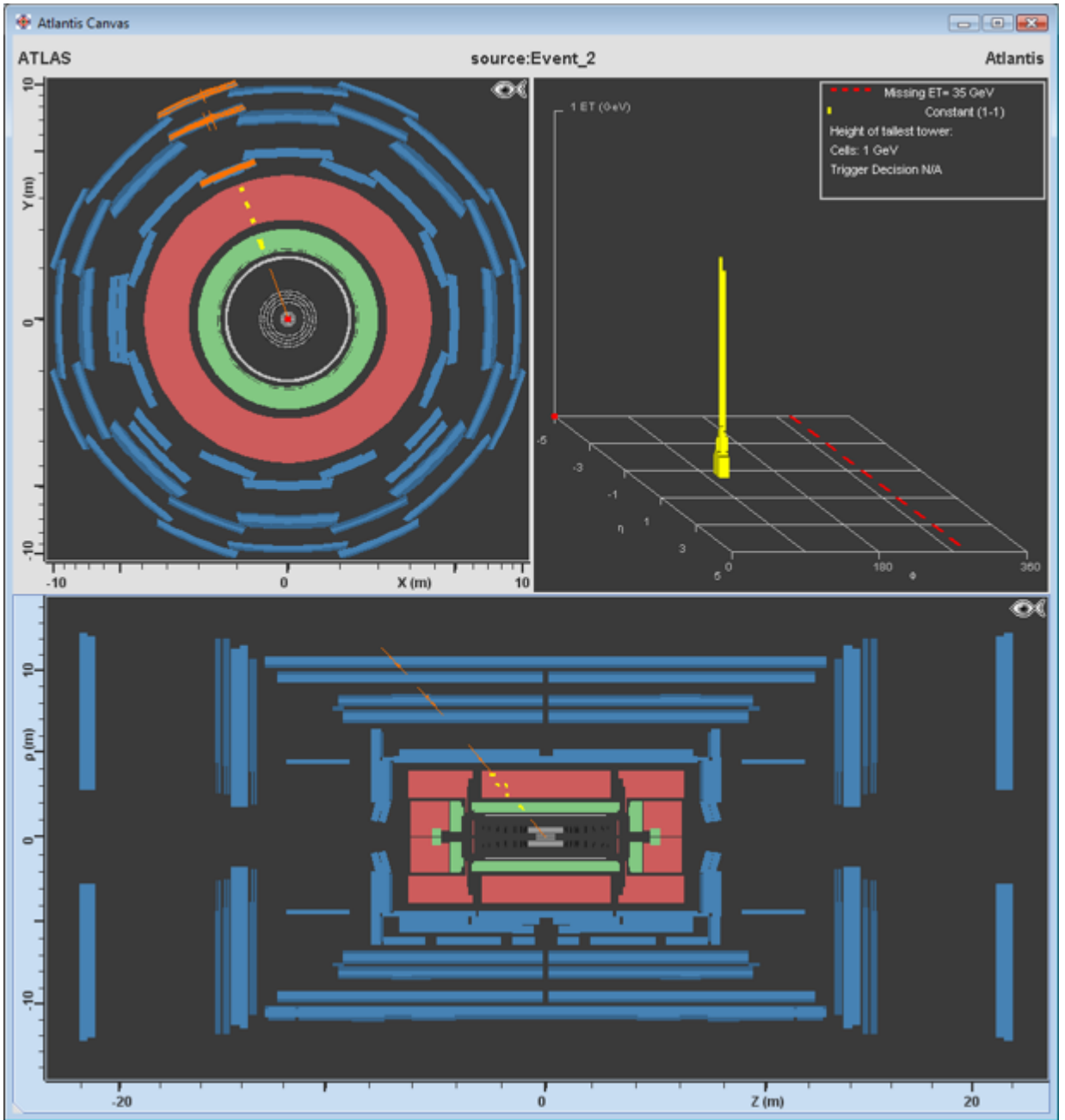
- P_T = transverse momentum
- Here, negative charge → electron

Muons/antimuons identification

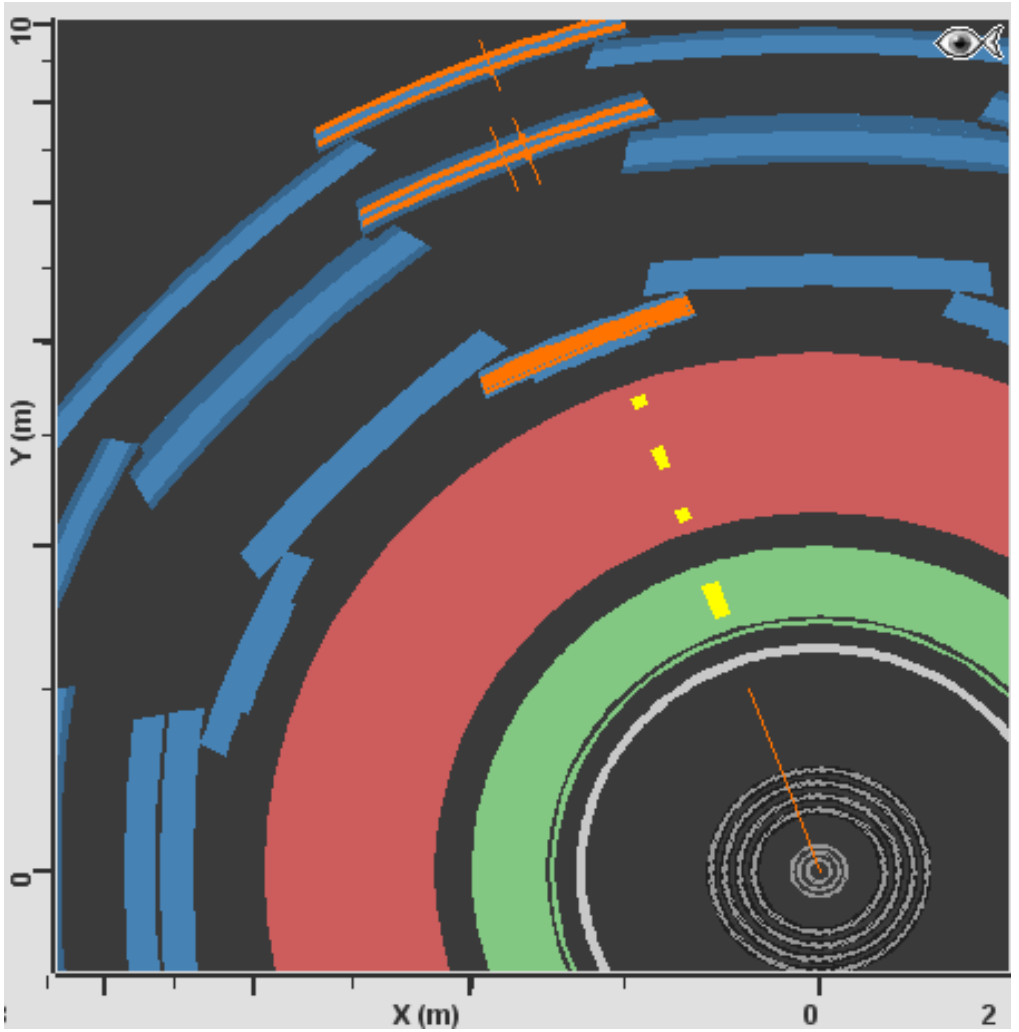
- Charged particle -> track in the tracker
- Few amount of energy in the calorimeter
- Track in the muon detector
- Curvature of the track → sign of the electric charge
- Not stopped by internal layers, travels through ATLAS



Identify muons/antimuons with Minerva

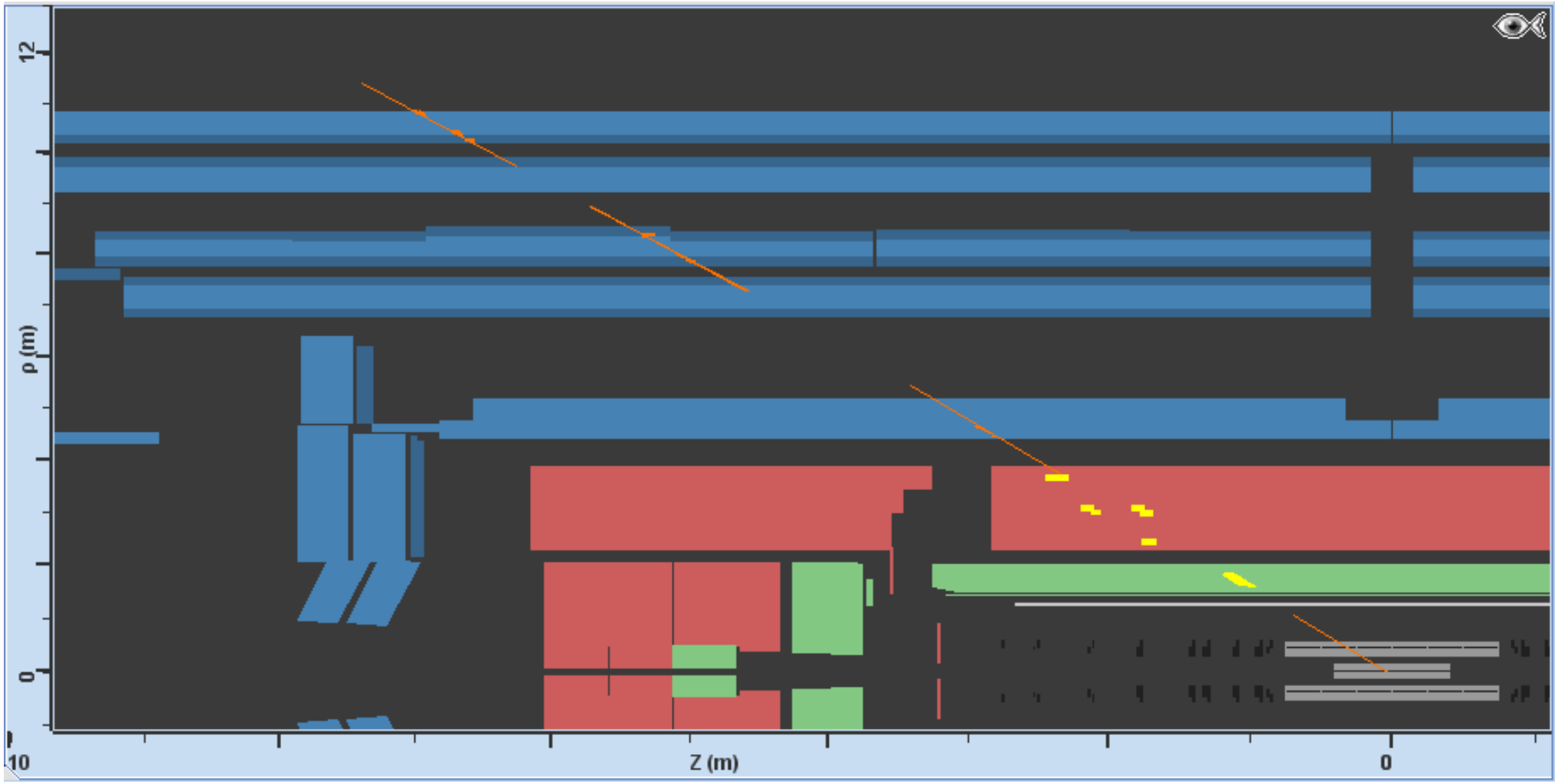


Identify muons/antimuons with Minerva



- Tracks in the tracker and muon detector (aligned)
- Some energy in the calorimeters

Identify muons/antimuons with Minerva



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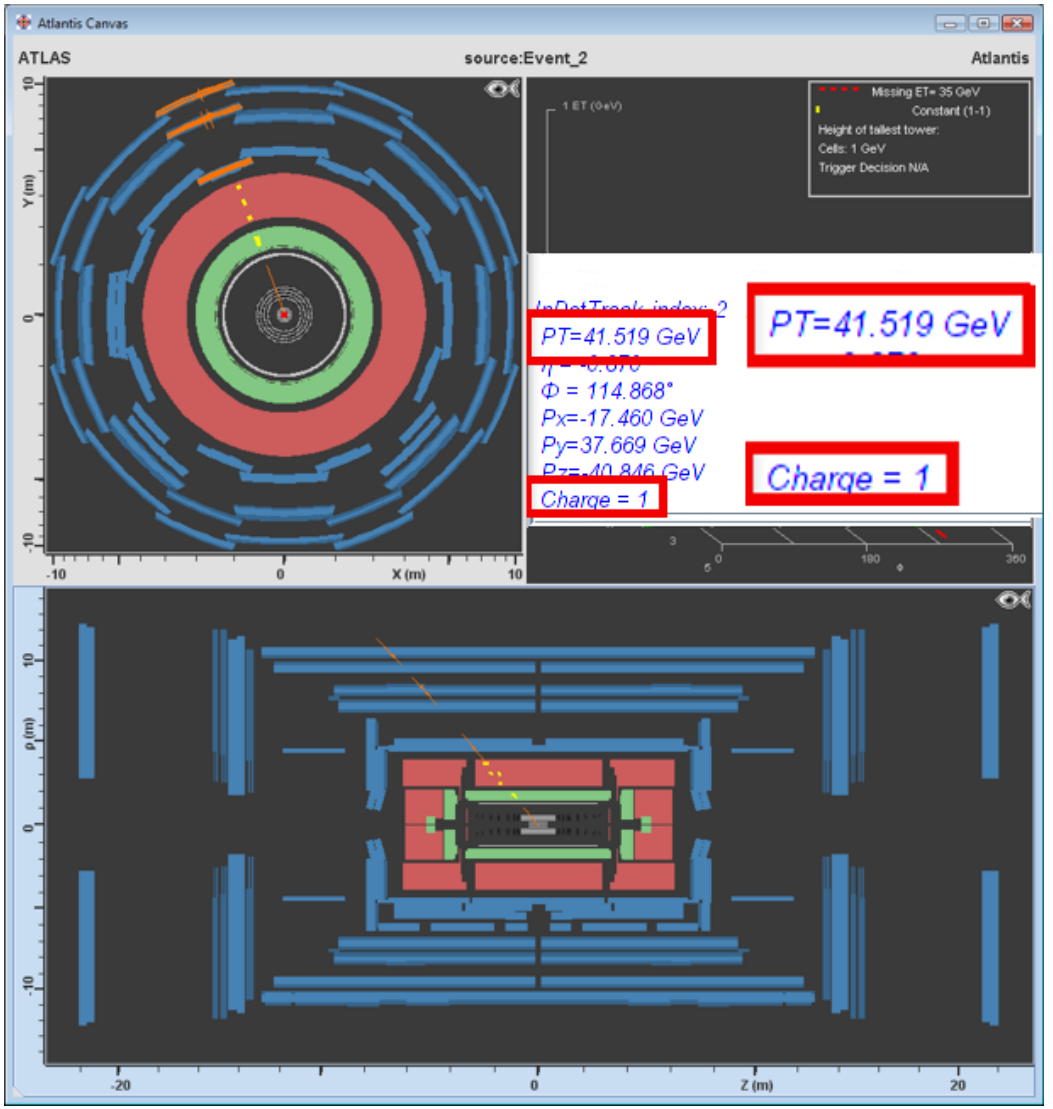
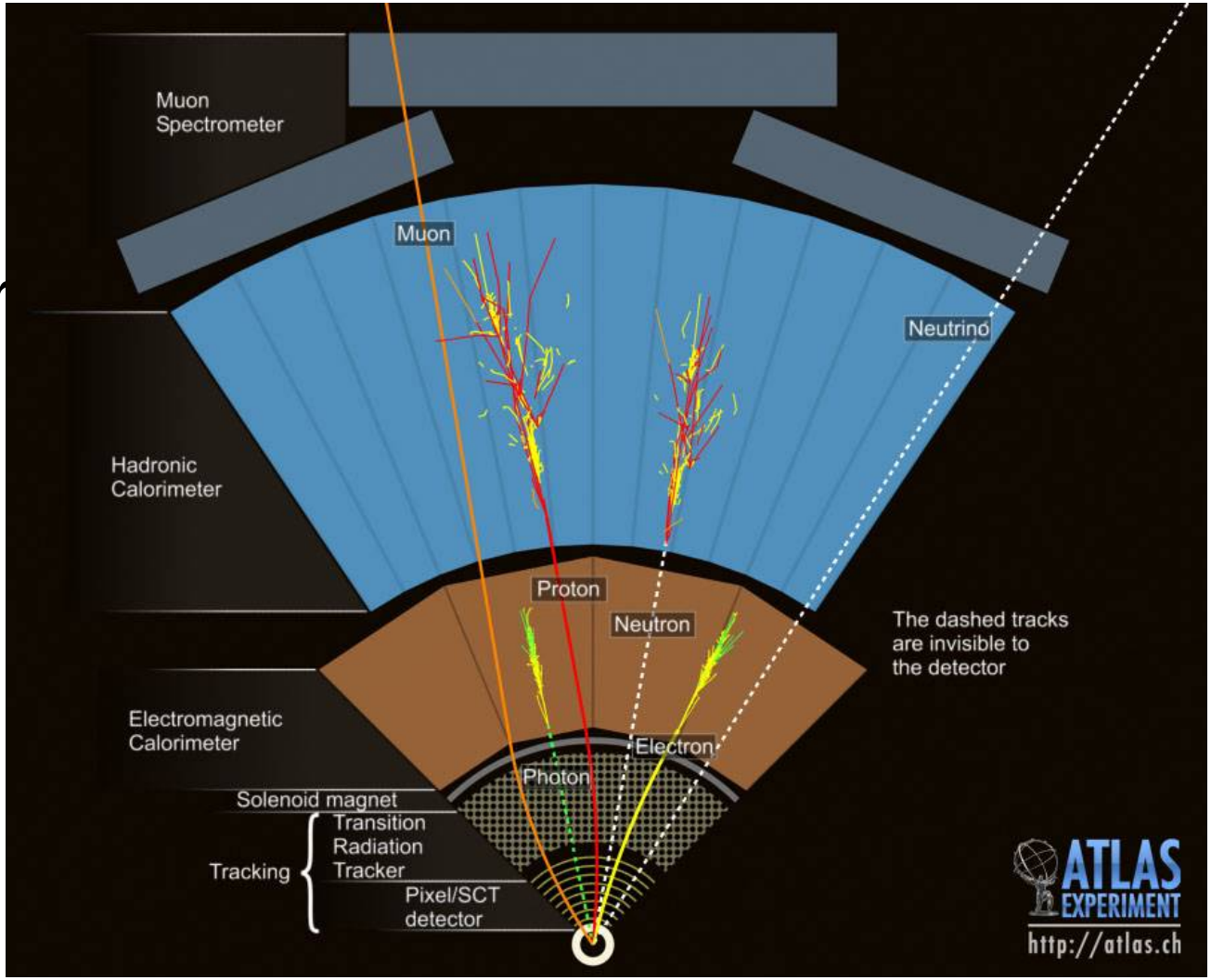
Identify muons/antimuons with Minerva



- Positive charge : antimuon

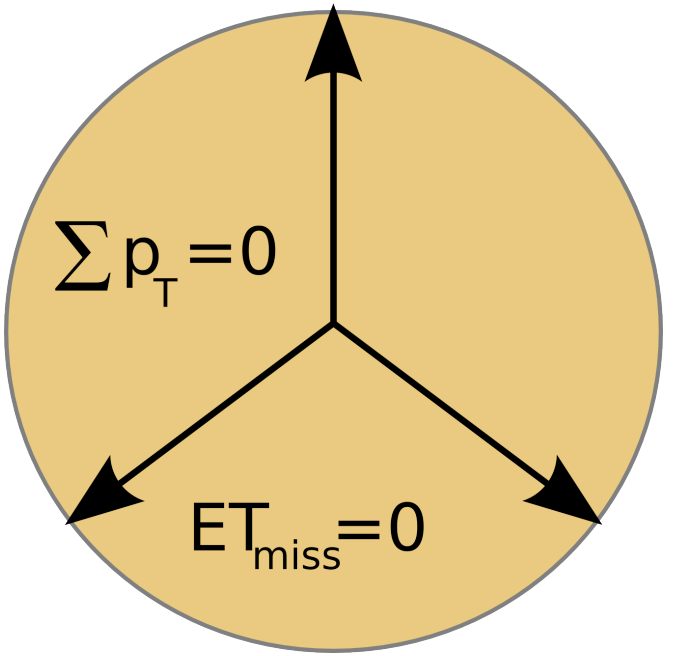
Neutrinos identification

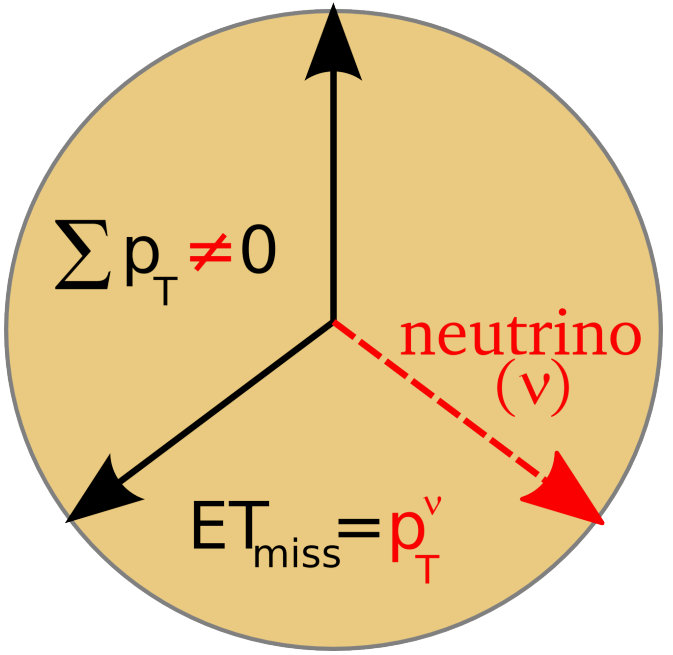
- Neutral particle which does not interact with matter
- No traces in the detector
- Identified indirectly using momentum conservation



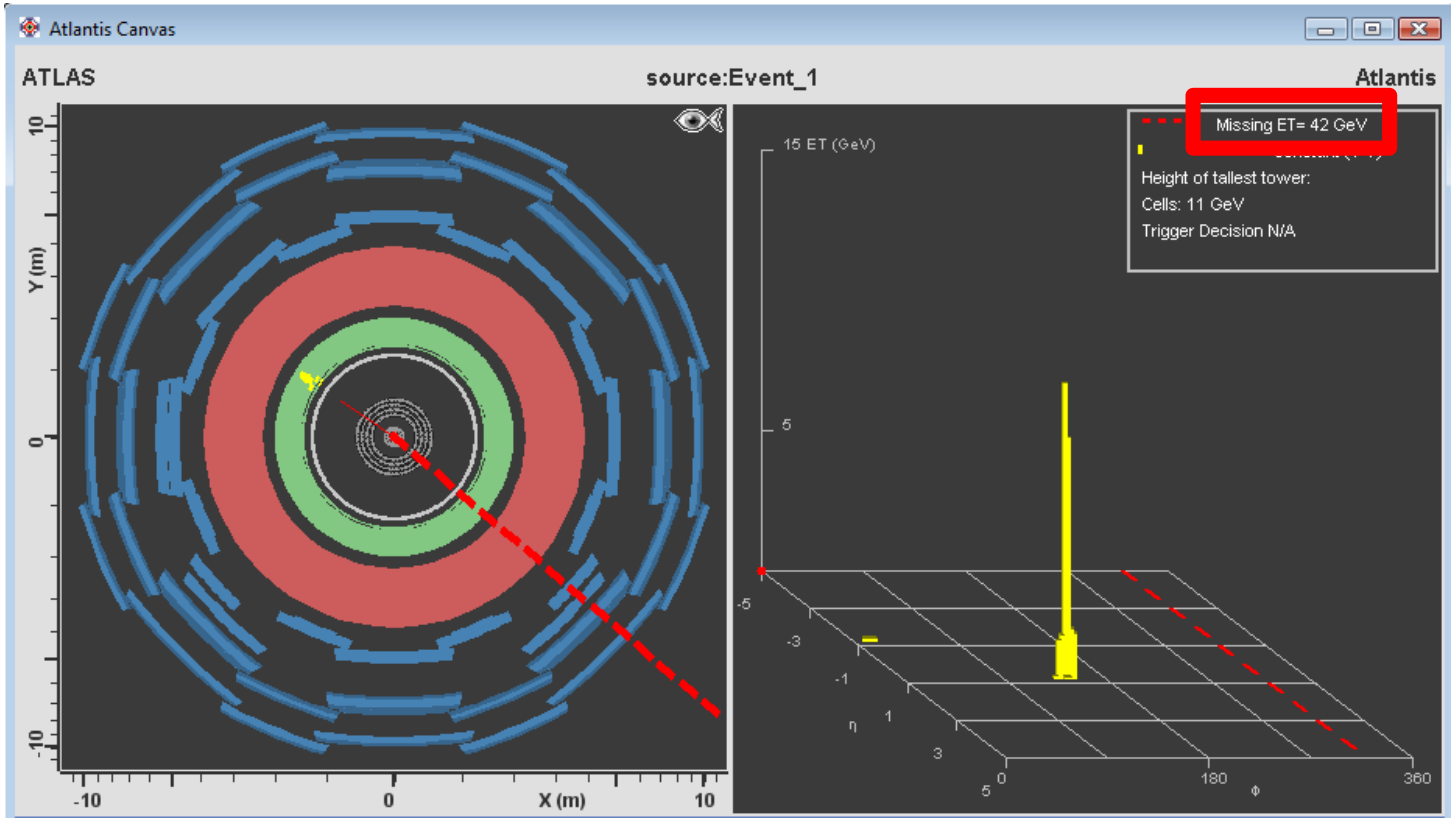
Missing transverse energy : E_T^{miss}

- Without neutrino
  - 3 reconstructed particles
  - In the transverse plane, sum of momenta : 0
  - So $E_T^{miss} = 0$
- With a neutrino
  - Part of the event is unseen
  - The sum of transverse momenta is non zero
  - The difference is E_T^{miss}, associated to the neutrino





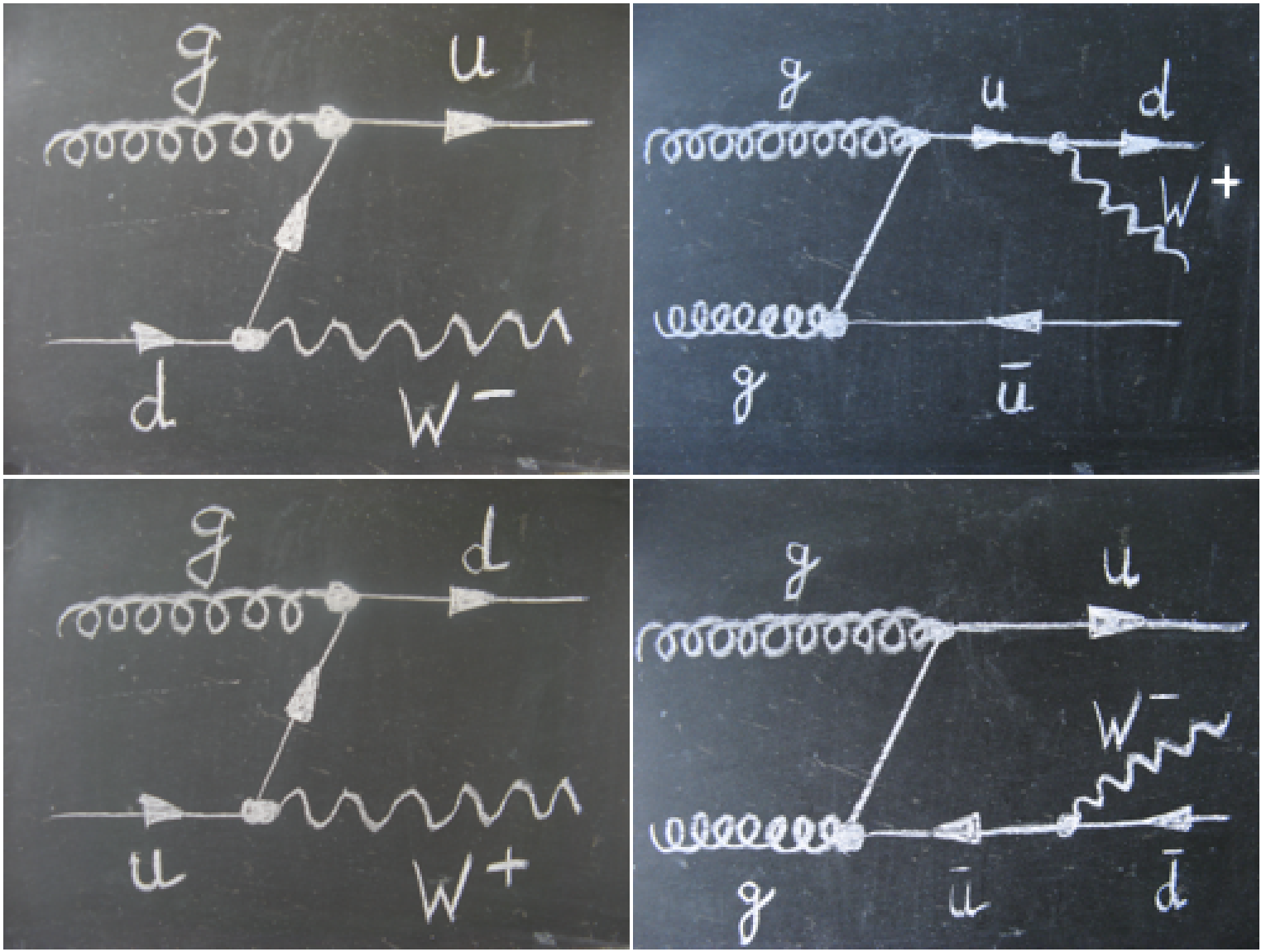
Neutrino identification with Minerva



- By conservation, the sum of momenta in the transverse plane is 0
- Else, Missing ET : unseen particles, or badly measured
- Representation with a dashed red line, value in the top right

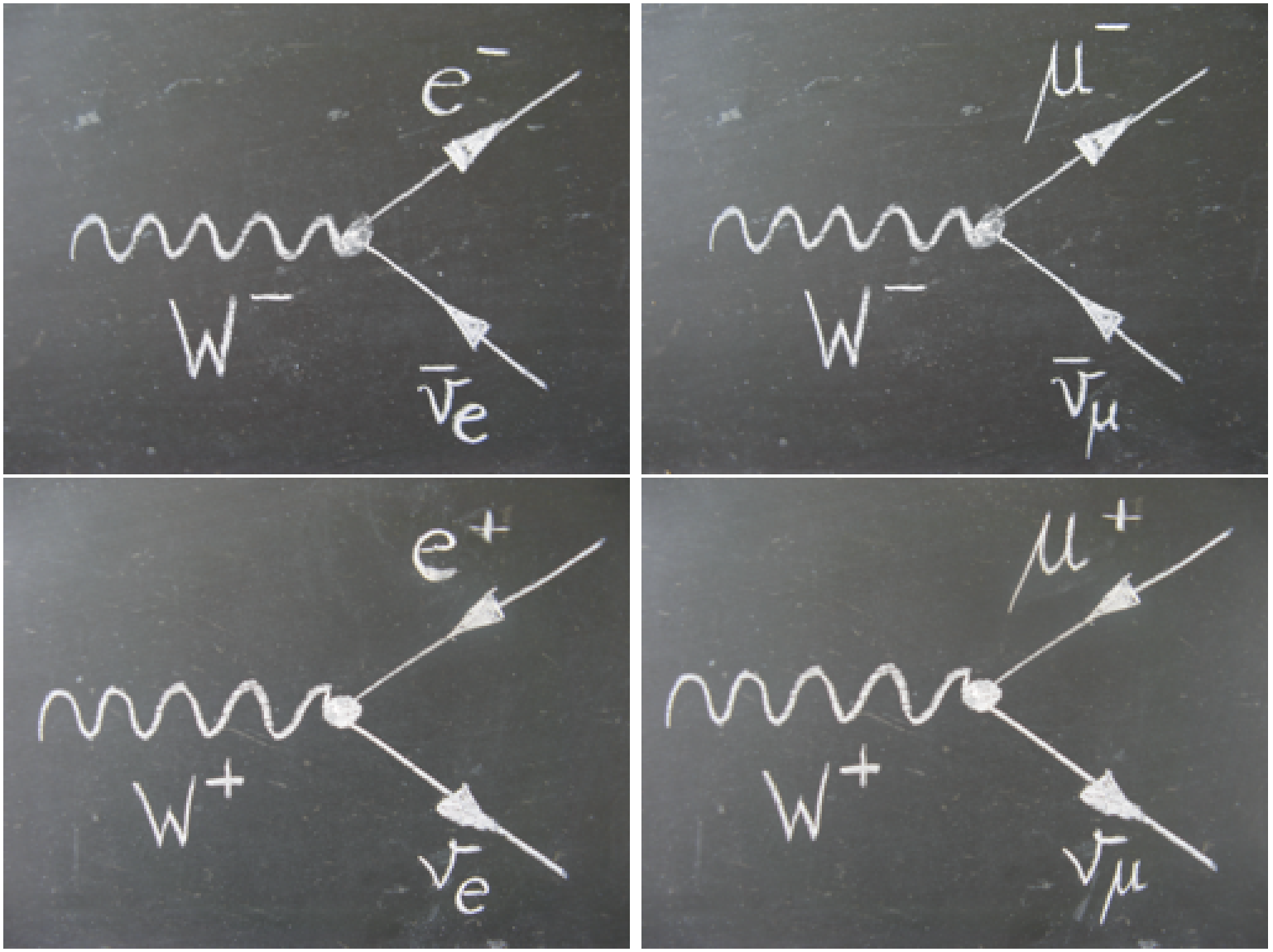
Analyse : W boson observation

Production



Analyse : W boson observation

Désintégration

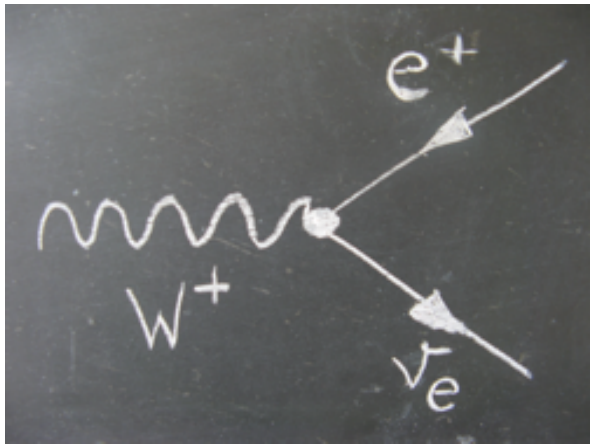


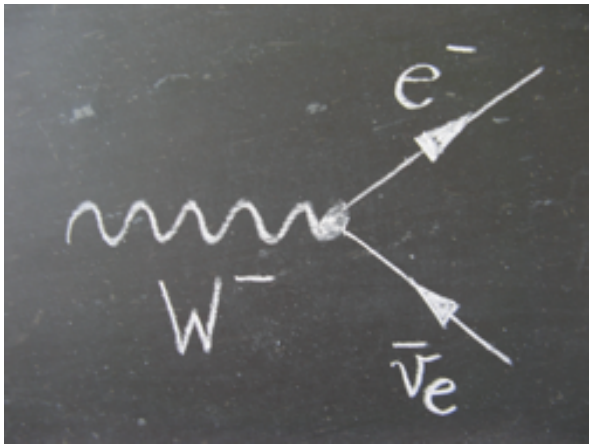
Difficulties : background

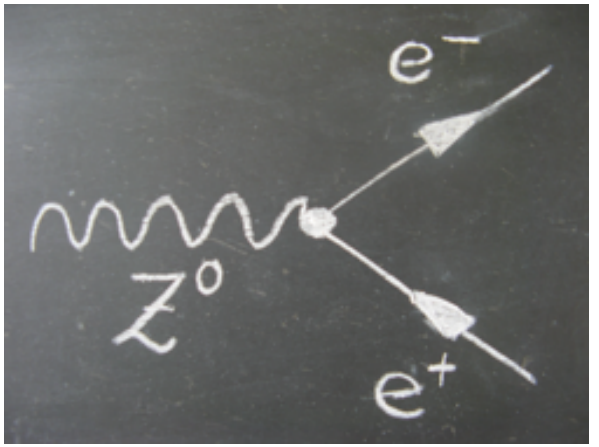
- Similar signature to what we look for, but coming from a different source
- Maybe a real process giving this final state ....
- ... or due to the fact that a particle was not observed
  - For example : escaping along the beam
- ... or due to a bad reconstruction
  - For example : there is a jet, but I think it’s an electron
- ... or due to additionnal particles
  - Every event contains several collisions

Examples of signal and background

- Signal : W boson decay
  $W \rightarrow e\nu$
- Background : $Z \rightarrow ee$
- One electron is not reconstructed







- If we look for *Z events*, then *W events* can be a background !

And you ?

- Looking for W bosons
  - And measuring the structure of the proton
- Searching for the Higgs boson
  - $H \rightarrow W^+W^- \rightarrow$ $e^+\nu\ e^-\nu$
    $e^+\nu\ \mu^-\nu$
    $e^-\nu\ \mu^+\nu$
    $\mu^+\nu\ \mu^-\nu$