Machine learning in particle identification

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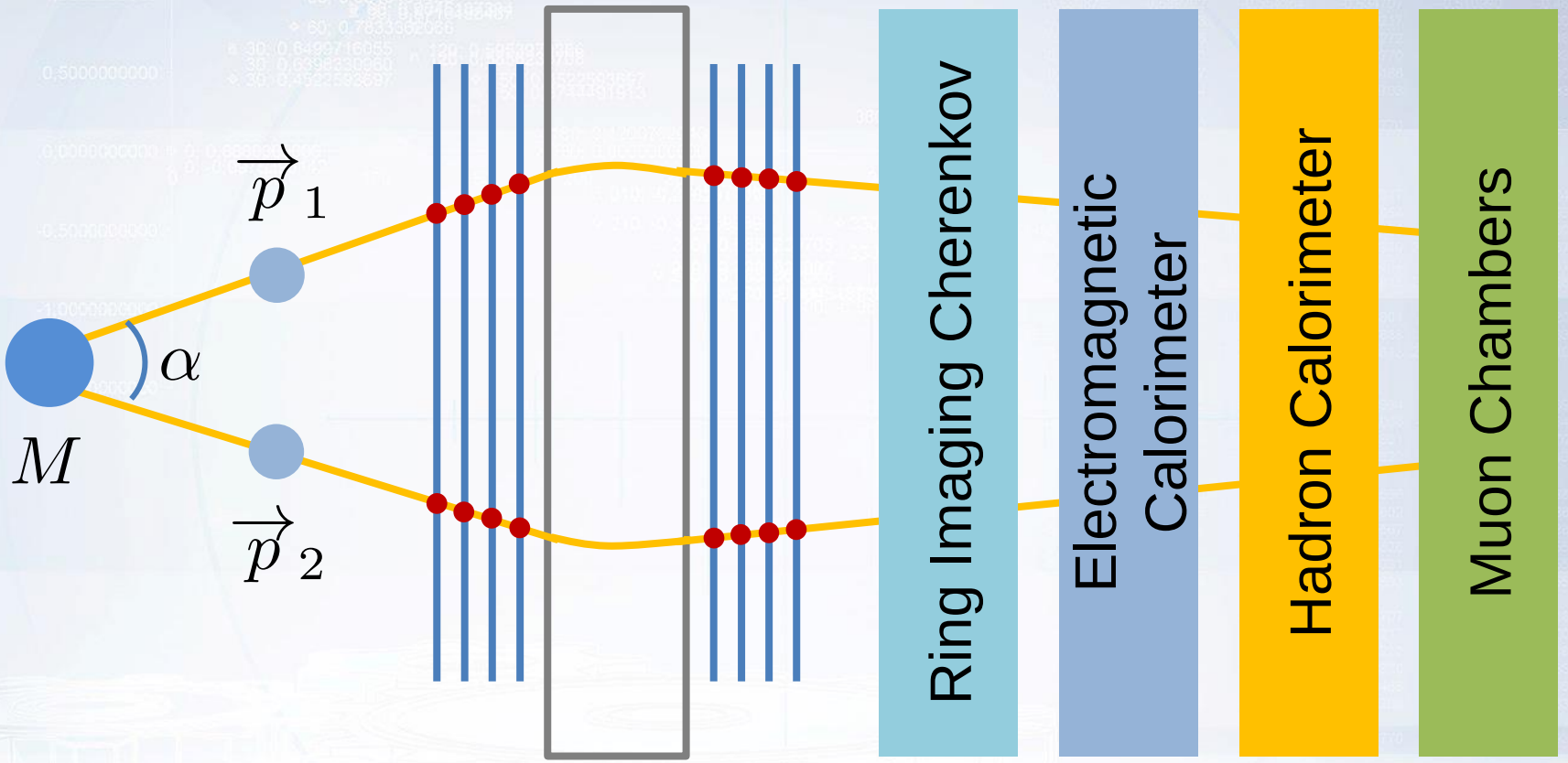
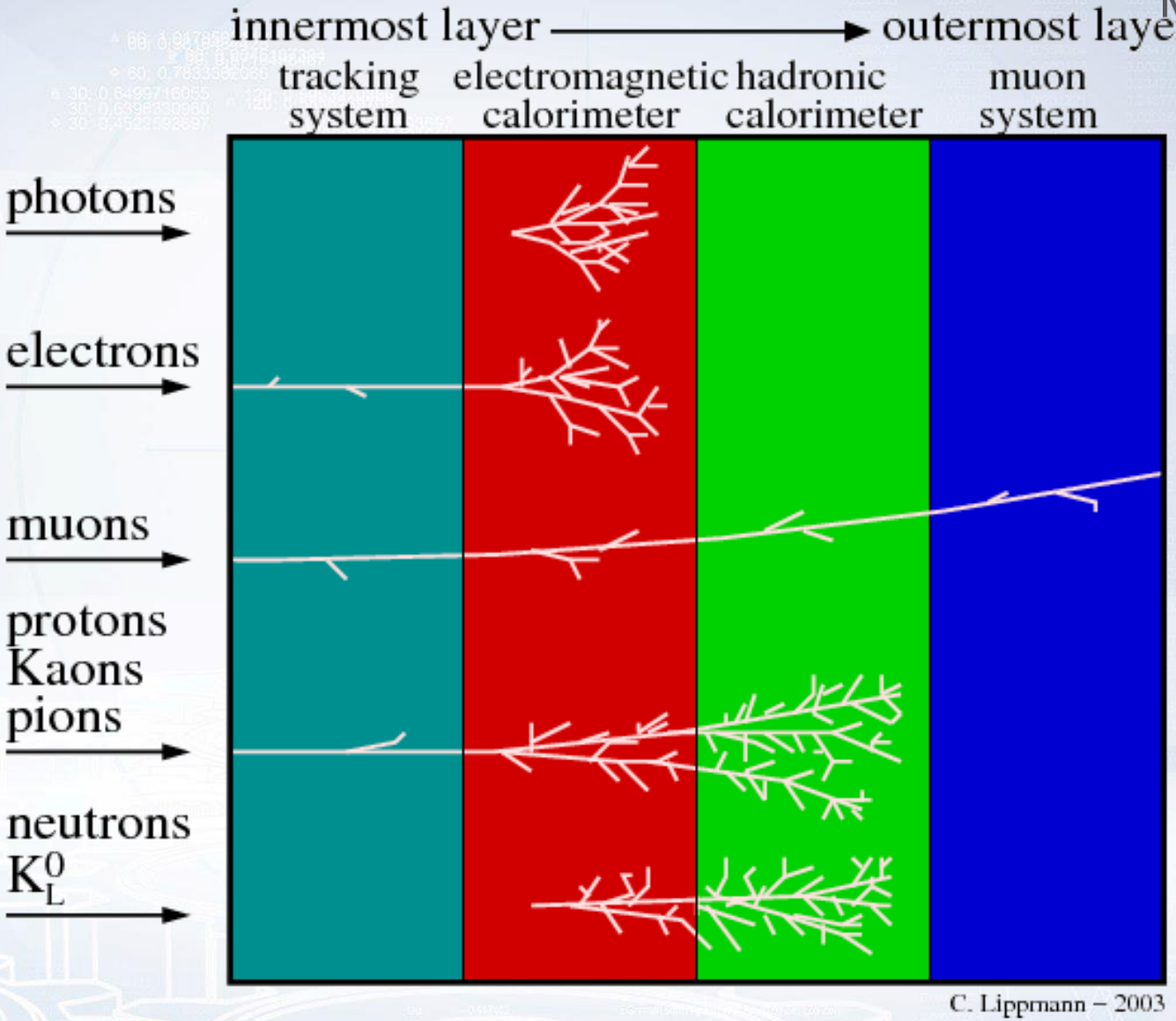
Overview



Momentum and charge estimation

Energy and particle type estimation

Overview



Lippmann / https://inspirehep.net/record/884672/plots

Problem statement

The goal of the **particle identification** (**PID**) is to identify a type of a particle associated with a track using responses from different subdetectors.

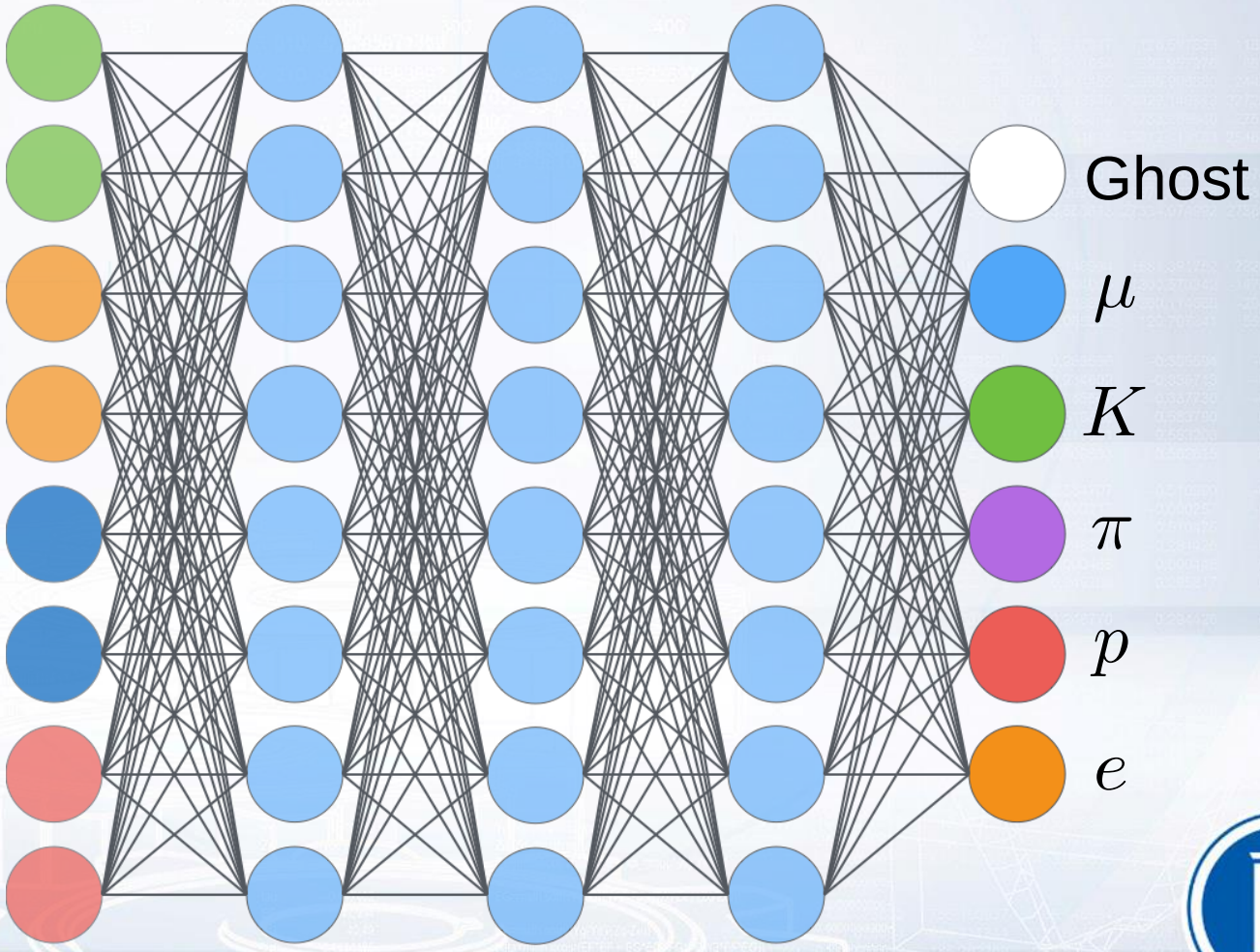
There are 5 particle types: Electron (e), Proton (p) , Kaon (K), π Pion ( ), μ Muon ( ).

Subdetectors:

- Tracking system
- Ring Imaging Cherenkov detector (RICH)
- Electromagnetic calorimeter (ECAL)
- Hadron calorimeter (HCAL)
- Muon Chambers

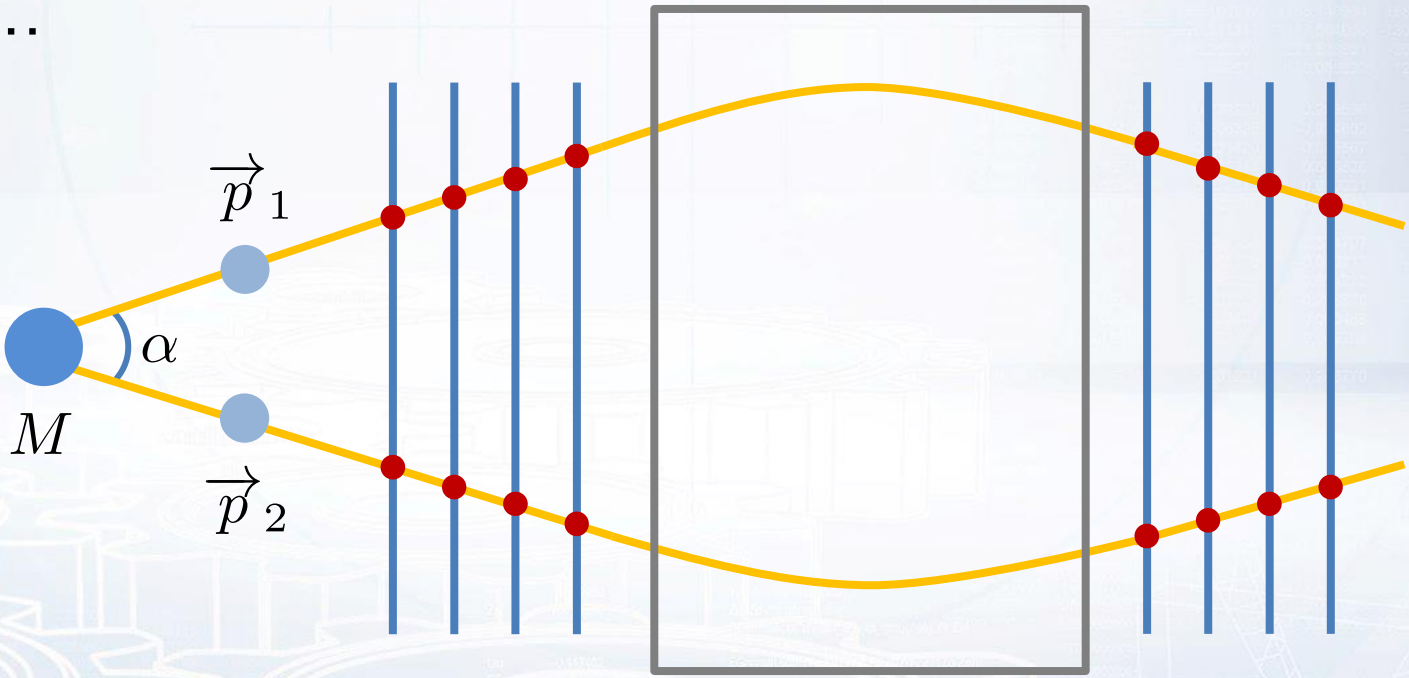
General idea

Particle identification is multiclass problem in machine learning:



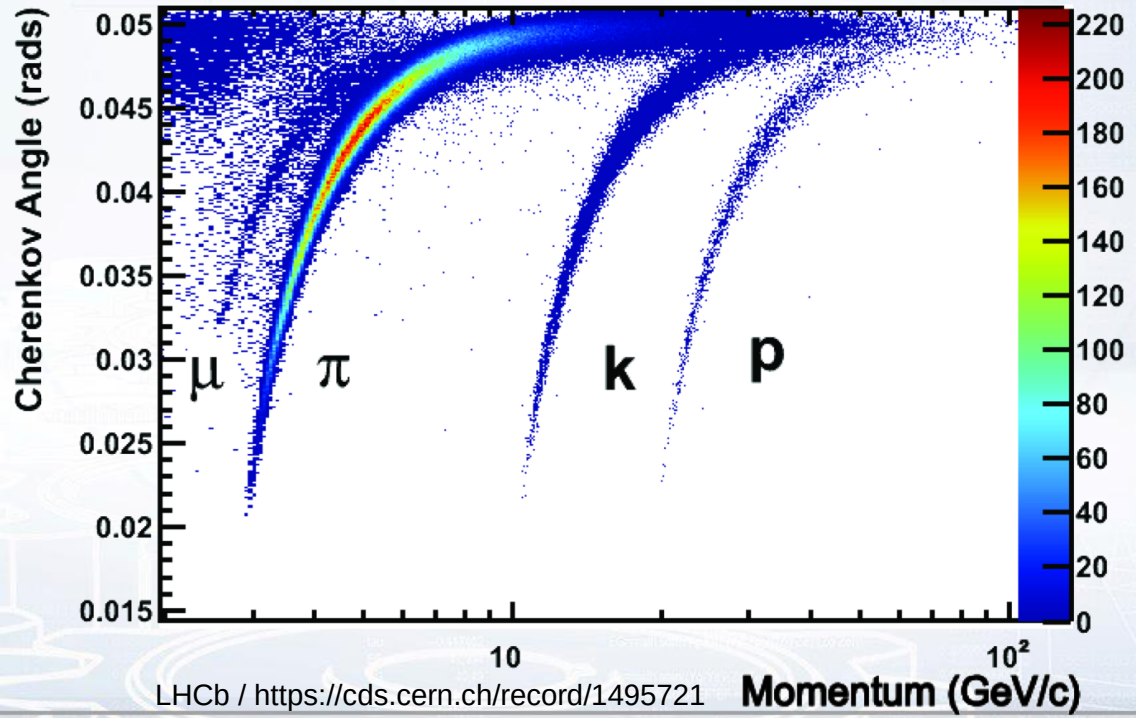
Tracking system features

- Particle momentum
- Particle charge
- Track parameters
- Quality of track fit
- Number of track hits
- …



RICH features

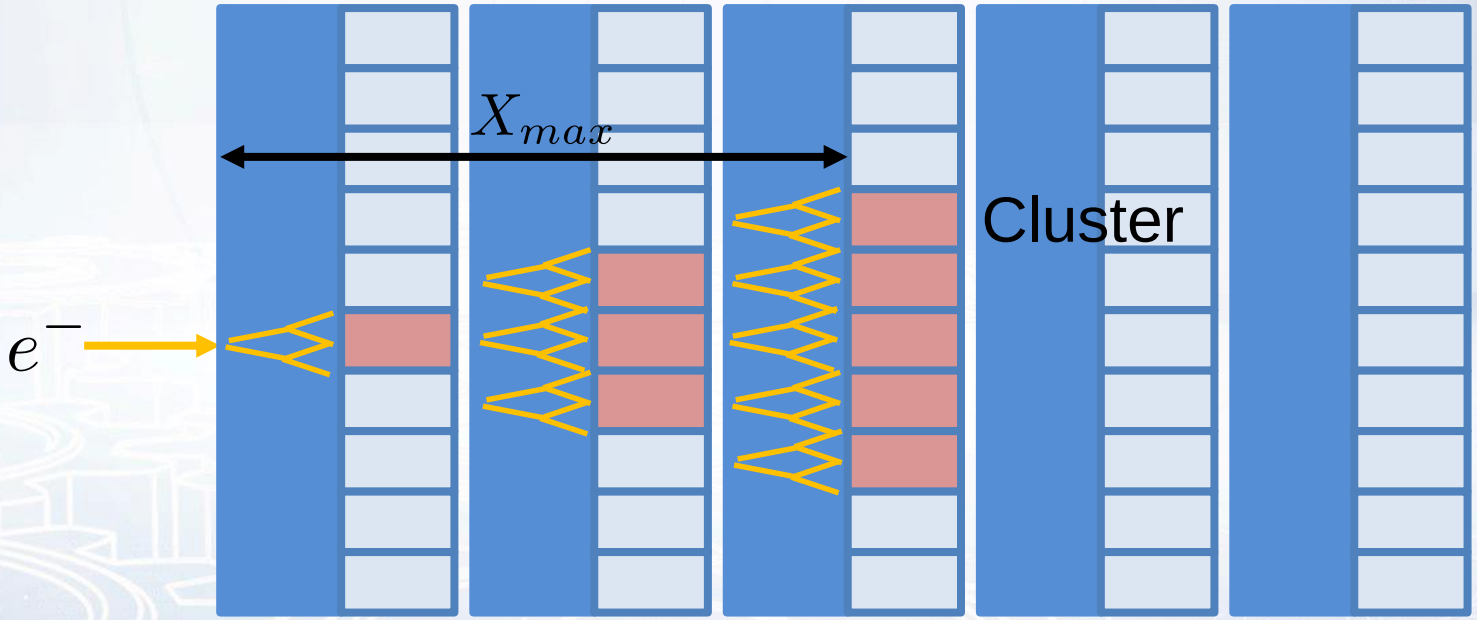
- Angle θ
- Quality of angle reconstruction
- Reconstructed particle type
- Reconstructed particle energy
- Light intensity
- …



LHCb / https://cds.cern.ch/record/1495721

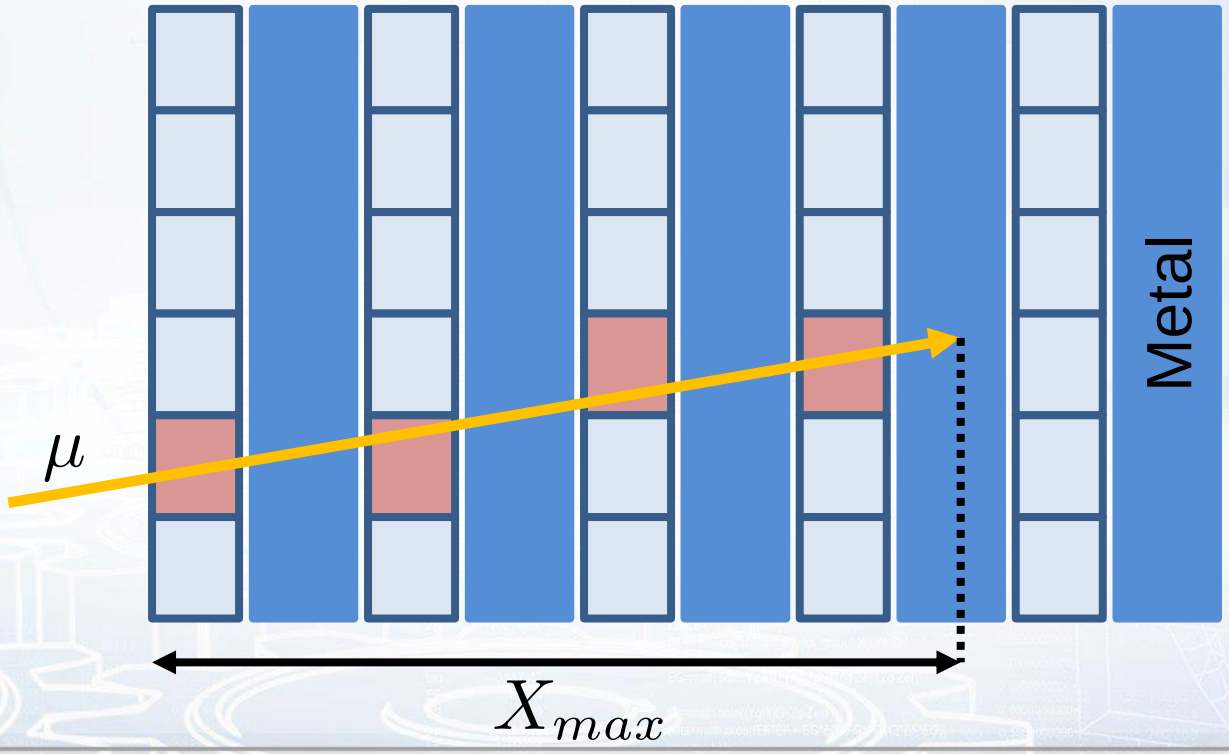
Calorimeter features

- Measured particle enegry
- Shower parameters: X_{max} ,width, ...
- Number of clusters in each layer
- Intensity of the clusters
- Distance form track of the original particle
- …



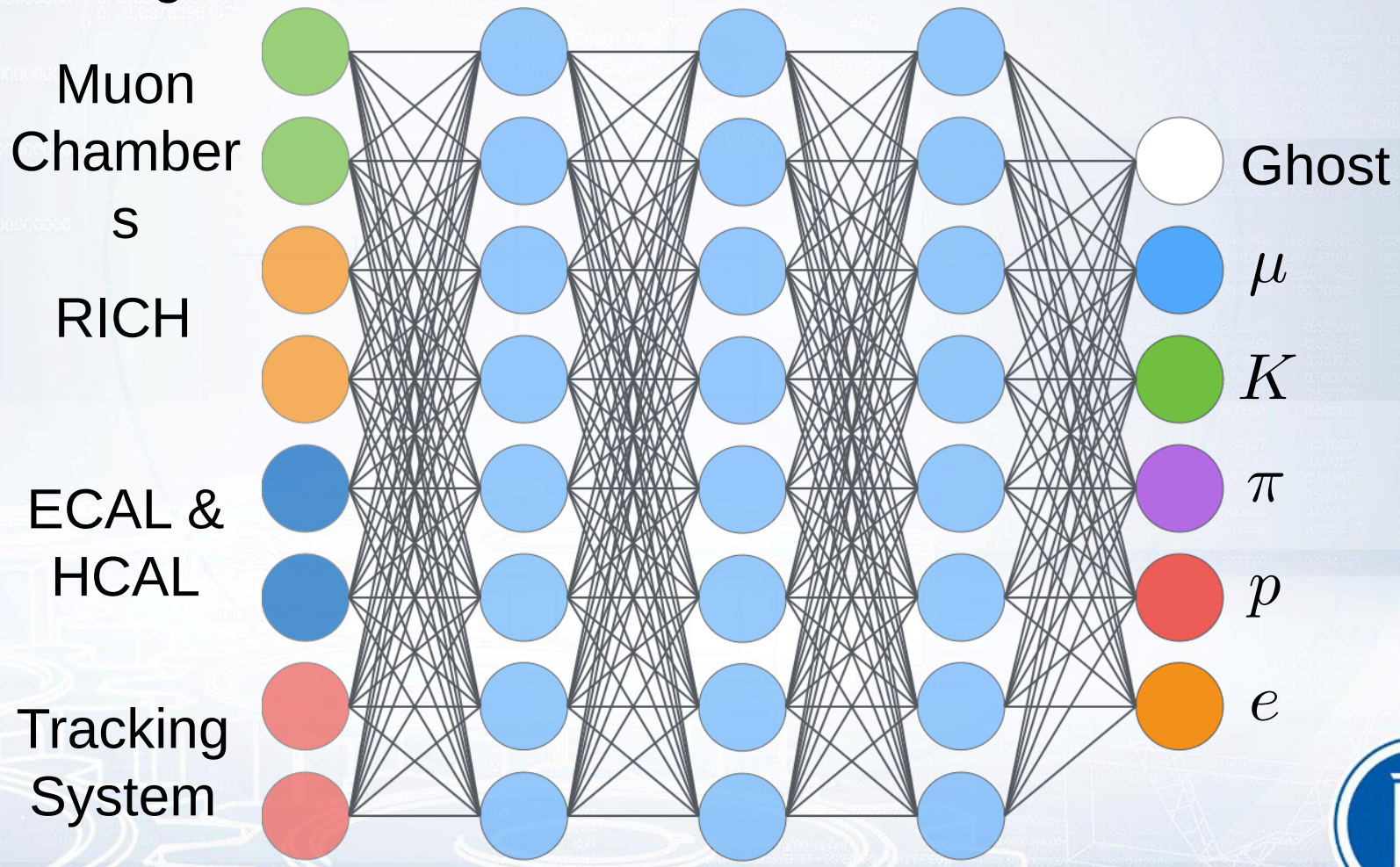
Muon chambers features

- Muon track parameters
- Quality of track fit
- Number of active chambers
- Distance between the track and the active chambers
- X_{max}
- …



Machine learning in PID

Particle identification is multiclass problem in machine learning:



Machine learning in PID

In modern experiments the particles are recognized very well: